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CAUSALITY RELATIONS BETWEEN THE EFFECTIVE EXCHANGE RATE IN IMPORTS AND INFLATION IN ISRAEL

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CAUSALITY RELATIONS BETWEEN THE EFFECTIVE EXCHANGE RATE IN IMPORTS AND INFLATION IN ISRAEL

by

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Abstract

CAUSALITY RELATION BETWEEN THE EFFECTIVE
EXCHANGE RATE IN IMPORTS AND INFLATION
IN ISRAEL

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Israel suffers for many years from high rates of inflation and large devaluations. Economic theory recognizes a relationship between those two variables but there is no agreement on the causality relationship between them.

This paper investigates this relationship between inflation and the effective exchange rate in imports by using the method of Vector Autoregressive (VAR) with monthly data. The result indicates that inflation is causing devaluation; this result repeats when using the impulse response function.

Since a Cost of Living Allowance (COLA) exists in Israel, the addition of this policy, in a deterministic

(known in advance) and non-deterministic (not known in advance) format, showed that the COLA policy together with the inflation have a large effect on the exchange rate in the deterministic model. In the non-deterministic model we find a major influence of the non-deterministic variable on the exchange rate and somewhat less significant influence on the prices.

The results obtained showed that the government policy to curb inflation in recent years was the wrong one. Instead of the attempt to control exchange rate, the government should have fought the inflation rate.

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I hope to continue to do economic research in order to understand human behavior.

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Chapter 1

INTRODUCTION

The Israeli economy from its first days experienced different rates of inflation. In the sixties (1960-1969) the per annum average inflation rate was 5.2 percent. In the seventies the rate of inflation increased to double-digit and triple-digit. The formal exchange rate ("par value" of the currency as registered with the IMF due to Bretton Woods rules) between the Israeli currency (Israeli pound and shekel later on) and the dollar devalued (depreciated) from .34IL/$ in 1949 to 35.35IL/$ in the end of 1979, a 104-fold increase, and 156.04IL/$ in the end of 1981 or a 459-fold increase. The depreciated value of the Israeli currency went through a few stages that will be discussed later. A different measure of exchange rate is the Effective Rate for Imports (formal rate + taxes on one dollar of imports: custom duty, surcharges, purchase tax and funds) that measures a change from .39IL/$ at the end of 1949 to 38.09IL/$ at the end of 1979, a 98-fold increase, and 189.15IL/$ in the end of 1981 or a 485-fold increase.

Economic theory does not have a unique treatment for the relationship between inflation and devaluation. Using the words of W.M.Corden, Some people point out that devaluation is obviously inflationary because it raises the domestic prices of traded goods, so that a system that provokes a devaluation must be conducive to inflation. Others might point out that inflation brings about devaluation, and vice versa.[1]

The causality relationaship between inflation and devaluation is of utmost importance at this time. The belief in the ministry of finance and Bank of Israel was that the exchange rate is causing inflation and, therefore, they adopted a policy of depreciating the formal exchange rate at 5% per month from the middle of 1981 to the middle of 1982 in order to control inflation. A different formula for slowing the increase in the formal exchange rate was in place before this period, still through controlling the exchange rate.

The aim of this paper is to zero in on the relationship between inflation and devaluation in the Israeli economy. The paper will describe the development of the exchange rate and inflation in the economy through the years. Vector Autoregressions (VAR) will be used to determine the Granger causality between inflation and devaluation for the period of October 1977 to January 1982 using monthly data. A transformation to quarterly data will

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1. W.M.Corden, Inflation Exchange Rate and World Economy, The University of Chicago Press, 1981, p.55.

be done in order to compare the results of this study to a study that was done on quarterly data for the years 1969-1979. Since there is a Cost of Living Allowance (COLA) policy in Israel which is paid at given dates and at additional times depending on the rate of inflation, this policy will be added to the original model, in order to arrive at a set of equations, with the anticipated COLA for the revaluation process of causality determination. The unanticipated COLA will be used to determine expectation behavior. The last model will incorporate all the variables to see their effect on the results. An impulse response function will be shown too, to show a dynamic response of the various systems to one standard deviation shock.

A simple manipulation of the data into a Purchasing Power parity (PPP) model is developed. The PPP model is an important part of exchange rate determination in a small country. The relative PPP approach will be used to see how the economy behaved along this front.

Chapter 2

THE EXCHANGE RATE AND INFLATION DEVELOPMENT

Before the establishment of the State of Israel, the Palestine pound was tied and backed fully by the British pound sterling. With the establishment of the State of Israel in May 1948 and the expulsion of Israel from the sterling block, the Israeli economy was facing a severe shortage of foreign currency. The shortage of foreign currency was due to the defense build-up resulting from fear of being attacked by the neighbors, the massive immigration and large investments.

The exchange policy that was adopted in 1948 came to solve the problems of the shortage of foreign currency as stated above. The choice the government had to make was hard and needed to answer questions like: "Should exchange control be retained or should international transactions be determined by market forces? Should the exchange rate be set by the authorities or by market forces? Should there be a unitary or multiple exchange rate system and, if multiple, should it consist of different formal rates or, if a single rate, transformed into multiple effective rates by use of subsidies and taxes? Finally, should the rate (or rates) be permanently fixed or subject to change, and, if so, how often, by how much, and by what methods?". [2]

The exchange rate that emerged was one that was always under government control. Formally there was a fixed exchange rate system under government control that will be called the Formal Rate and a system that incorporated taxes on imports, custom duty, surcharges, purchase tax and funds on imports that will be called the Effective Rate. (On exports the government helped with subsidies to get an effective rate of exchange for exports). This system with formal rate and effective rates did allow government to change the effective exchange rate without devaluating the currency (formal rate); the change of the effective rate through the years was very intensive.

The development and changes in the exchange rate can be divided into four stages:

a. <u>1948-1972</u> This period of time is identified as one with long periods of constant formal exchange rates, and changing effective rates, beside 1952-54 that had three formal rates. The effective rates were increasing continuously (2.21 to 2.60IL/$ between 1955-62 and 3.47 to

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2. Nadav Halevi, "The Exchange Rate in Israel: Policy and Opinion", <u>The Maurice Falk Institute for Economic Research in Israel</u> Research Paper 88, March 1979, p.11,, Published in <u>Revue 'economique</u>, vol.30, No.1, Janvier 1979.

3.68IL/$ between 1962-67) while the formal rate was kept constant (1.80IL/$ between 1955-61 and 3.00IL/$ between 1962-67). The large devaluation of the Israeli pound in 1962 (1.80 to 3.00IL/$) was with the intention to unify exchange rates, the subsidies to export were abolished and custom duties were reduced, but the increase in prices that followed the 1962 devaluation brought back all the subsidies and custom duties. In 1962 the Israeli economy started a trend of import tax reductions due to a commitment made to the European Economic Community (EEC). The devaluation of 1968 (from 3.00 to 3.50IL/$) was due to the devaluation of the British sterling.

The formal rate shows little change in this group of years, because the government did not want to change the exchange rate for political reasons, and preferred to keep the system with the effective rates.

b. <u>The years of 1973-75:</u> This period brought about a few important changes to the international finance arena: adoption of a floating exchange rate system by the United States, the oil crisis and the October war in the Middle East.

The oil crisis and the October war caused a worsening in the balance of payments situation, increasing the annual inflation rate (measured by CPI) from an average yearly rate of 12 and 13 per cent in 1971 and 1972 to 39.7 and 39.3 per cent in 1974 and 1975 respectively. 1973 had a 20 per cent inflation rate. [3]

Expectation of devaluation caused large speculative transactions in foreign currency and a significant reduction in government reserves of foreign currency holdings. The government adopted a new economic policy with the aim of increasing exports and reducing imports using the tax system and other methods to achieve it. This policy in 1974 was implemented through the exchange rate system by an increase in tolls on imports and subsidies to exports. The formal rate was increased from 4.20IL/$ to 6.00IL/$, a 43 per cent increase (Nov. 1974), and inflation followed as stated above.

The government realized that the devaluation policy is wrongly treated. Ordinarily a policymaker has a choice of a small frequent devaluation in the formal exchange rate or infrequent large ones. The policymaker in Israel preferred large devaluations until 1974; in addition, the view was that a devaluation is the last resort as a policy.

A close look at the large devaluations of 1974, the first large devaluation after 1962, pointed out a few of the

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3. Statistical Abstract of Israel, 1980, No. 31, Central Bureau of Statistics, p.240.

weaknesses of large devaluations compared to a more flexible devaluation policy. According to Barro and Sussman: [4]

1. Between one formal devaluation and another the policy was to maintain a flexible effective exchange rate on imports and exports, by varying the tax on imports and the subsidy for exports. This policy of many different effective exchange rates was discriminatory between the current account and the capital account and discriminatory between various products as well.

2. Formal devaluations were postponed to the last minute and therefore triggered large speculative activites in foreign currency regardless of controls. These activities caused a large loss of reserves below what is called the red line. When the government finally did devalue, they had to devalue by more than necessary to reverse the loss of foreign capital.

3. The reduction in reserves before a devaluation caused a monetary tightening that was relieved by expansionary monetary policy. After the devaluation the reserves were restored (reverse in expectations) and caused a monetary expansion, because the Bank of Israel could not

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4. M. Bruno and Z. Sussman, "Exchange Rate Flexibility, Inflation, and Structural Change: Israel under Alternative Regimes", The Economic Quarterly, vol. 25, NO. 99, Dec. 1978, p.272-3.

go back fast enough to a severe tightening in money supply. These effects caused a large deviation and a high money supply on the average.

4. Every devaluation, after a long period of time of export support and import taxes, was a lot higher for capital account than for current account. The monetary expansion that followed the devaluation was therefore large, relative to the increase in import and export price; this eliminated the effect of the small initial differential in relative prices of tradeable and nontradeable goods.

Because the private sector was a net holder of large foreign and indexed assets, the net wealth of those assets after a devaluation increased enormously and it was hard to control the wealth effect on the increased aggregate demand that followed.

5. A large devaluation had a strong and immediate effect on prices and wages because all the groups of workers, employers, etc., wanted to restore their real wage and income.

6. The effective exchange rate for exports, although being more flexible than the formal rate, remained uncertain from the exporters' point of view because there was no clear policy the exporter could rely on in his long run planning; it seems that it had an adverse effect on the profitability

of the exporting industry.

In general there are additional effects that were not pointed out by Bruno and Sussman, as stated by J.Yoran. [5]

7. Unnecessary profit to existing production rather than incentives to change production patterns.

8. Distortion in the economy caused by delayed devaluation or by interim palliatives - taxes and subsidies.

9. In addition it seems to me that the episodes of government treatment of devaluation, change of money supply and the inability to hold the prices down was preceived by the public as a loss of government credibility due to stop and go policies. This perception caused an adoption of a more rational behavior by the public based on future policies and expectations.

c. The crawling peg of 1975-1977: Starting in June 18, 1975, the Israeli government decided to adopt a crawling peg of the Israeli pound in relation to the U.S. dollar, where each devaluation will not exceed 2 per cent in order to minimize the speculative gain that one can try to gain from an expected devaluation. In addition a minimum of 30 days was required between those small devaluations or not

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5. J.Yoran, "On the Exchange Rate Policy", The Economic Quarterly, Vol.22, No.86, Aug.1975, p.163-172. As stated in N. Halevi, "The Exchange Rate in Israel: Policy and Opinion", p.18.

more than a 27 per cent devaluation for the year. During the summer of 1975 the U.S. dollar gained value against the European currencies and the crawling peg policy in relation to the U.S. dollar was not sufficient, deteriorating the terms of trade. A once-and-for-all devaluation of 10 per cent was announced on Sept. 28, 1975, as a correction measure.

In July 1976 the crawling peg was removed from the U.S. dollar to a basket of currencies in order to eliminate the fluctuation in the Israeli pound caused by the tie to the U.S. dollar which affected exports to Europe. The basket was made of currencies of countries Israel was exporting to, giving the countries' currencies their relative weight in the basket equal to the trade weight. At the same time a ceiling of 8 per cent per month was put on the devaluation. In July 1977 this was changed again to a maximum of 2 per cent in every devaluation.

During this period all the tolls on imports remained as before, which means that the effective rates were still in use, and still with no single unitary rate of exchange.

The increase in prices as measured by CPI and exchange rate development through the years 1970-1981 is shown in table 1.

TABLE 1

Inflation and the Exchange Rate 1970-1981 [6].

Yearly change in CPI			Yearly Exchange rate IL/$ end of period			
	Ave	End	Formal	% ch	Effective	% ch
1970	6.1	10.1	3.5	0	4.42	0
1971	12.0	13.4	4.2	20.00	5.09	15.16
1972	12.9	12.4	4.2	0	5.11	.0004
1973	20.0	26.4	4.2	0	4.75	-7.04
1974	39.7	56.2	6.0	42.86	5.43	14.32
1975	39.3	23.5	7.1	18.33	7.36	35.54
1976	31.3	38.	8.81	24.08	9.37	27.31
1977	34.6	42.5	15.39	74.69	17.49	* 86.66
1978	50.6	48.1	19.02	23.59	22.42	* 28.19
1979	78.3	111.4	35.35	85.86	38.65	* 72.39
1980	131.0	132.9	75.48	113.52	85.01	*119.95
1981	116.0	101.5	156.04	106.73	180.05	*111.80

Ave is the average yearly.
End is the end of the year.
* is the author's results from app A.3.

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6. Statistical Abstract of Israel 1982, No.33, p.234 and p.246. and N.Halevi, "The Exchange Rate in Israel: Policy and Opinion", p.15.

Shortly after the election of May 1977 a new government (previously in the opposition) took office and a new economic policy was adopted. The new ideology included some reduction in government interference. The new government blamed the previous one for the high rate of inflation and decided to take a dramatic step in order to signal the public about the change. The new leadership's objective was to cause a structural change and increase growth. Some of the steps to achieve these new objectives are listed in d (only those that matter for this paper).

d. Floating exchange rate: Oct. 1977 was when the government decided to introduce a major change in the currency policy. The steps taken were as follows:

1. Abolish control on foreign currency,
2. Eliminate the different exchange rates by eliminating the 15 per cent toll on imports and abolishing the export subsidies,
3. Introduce a floating exchange rate, and
4. Devalue the pound from 10.5IL/$ to 15IL/$ as a first step to help export.

All the above steps were caused by a new government view towards the economy, a view in favor of free market and less government involvement. The free floating rate eliminated the problem of speculative expectations for large devaluations. Following the first period after the initial devaluation, there was no major speculation scheme; the devaluation was somewhat accelerated, compared to the previous period (c), and the involvement of the Central Bank was quite limited. After an initial period of time the Central Bank got more involved in controlling the exchange rate; this period can be identified as "controlled floating". One should notice that the public was holding more in foreign currency than in any time in the past deposited in the Israeli banking system.

The average increase in prices for 1978 and 1979 were 50.6 per cent and 78.3 per cent respectively; the average devaluations for 1978 and 1979 were 25 per cent and 94 per cent respectively.

During part of this period a "purchasing power parity" (PPP) policy was adopted by Bank of Israel between Feb. 1979 and Dec. 1980. The PPP policy which is "the multiplication of the increase in exchange rate times the increase in Israel's export and import prices abroad (in foreign currency) should be equal to the increase in the Israeli price level".[7] The policy meant to keep the relative formal exchange rate change at the same rate the

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7. M. Michaely, "Inflation and Money in Israel After the 1977 Reform". The Economic Quarterly, Vol.28, No.109, July 1981, p.135.

price level changed without attention to the effective rate (for more detail see chapter of PPP).

Chapter 3

DEVALUATION AND INFLATION - DYNAMIC INTERACTIONS

Inflation and devaluation might interact in many ways. M. R. Darby, et al lists four different ways of international transmission of inflation: [8]

> First, change in foreign prices effect domestic prices through a Humean price-specie-flow mechanism, which can occur either within a quarter or more slowly over time. Imports and exports are effected, by current and lagged changes in domestic prices. Unless this change in the balance of trade is exactly offset by a change in net capital outflows, it affects the balance of payments. But current and lagged levels of the balance of payments can affect nominal money growth and hence inflation.
>
> Second, changes in the expected foreign inflation rate may affect the demand for domestic money through a currency substitution channel. Thus a permanent change in foreign inflation may have a temporary effect on domestic inflation through this channel.
>
> Third, variables affecting international capital flows affect domestic inflation through their effect on the balance of payments and hence the nominal money supply.
>
> Fourth, changes in foreign real income may affect the domestic price level through an 'absorption' channel: changes in income may affect the balance of payments and hence the money supply and price level by affecting either the balance of trade or capital flows. Furthermore, export shocks may affect domestic real

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8. Michael R. Darby and Alan C. Stockman, "The Mark III International Transmission Model: Specification" p.98-99, in Michael R. Darby, James R. Lothian, Arthur E. Gandolfi, Anna J. Schwartz, and Alan C. Stockman, "The International Transmission of Inflation", University of Chicago Press and The National Bureau of Economic Research, Chicago, 1983, p.85-112.

income and, through the demand for money, the domestic price level.

In the short run, the adjustments' period of time, the economy is influenced by all kinds of rigidities in price change and exchange rate changes; therefore, the speed of adjustment varies for those two elements.

In the literature we note two different treatments of the issue mentioned. Israel has two views regarding the transmission of inflation as discussed by J. Flanders: [9]

> The disagreement (between economists) emerges from the question how can you, or what is the best way to influence the total expenditure, and how and at what level to change (or not change) or influence the exchange rate... Who will carry the burden of the reduction in expenditures? Who should carry the burden if a drastic change in the exchange rate and price rations between different kind of goods takes place?
>
> We have two different approaches: the Tel-Aviv one and the Jerusalem one. Here in Tel-Aviv we tend to look at the market as a place where things should occur. We think that the private sector is more efficient than the public sector, and that the private sector makes better decisions... and that the individual does not have enough influence on his choices of spending: the public sector is too large.
>
> The Tel-Aviv approach is that a reduction in government spending might cause unemployment, but it is reasonable to assume that the unemployment will not be too large, and will not continue for too long...It is thought that the effective exchange rate, the real, is

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9. Y. Alshech, H. Ben-Sahar, E. Berglas, M. Bruno, E. Helpman, Z. Sussman, L. Flanders, A. Rasin and A. Shavit, "Balance of Payments, Foreign Debt and Economic Policy (a symposium)", The Economic Quarterly, Vol.26, No.103, Dec.1979, p.374-75. Translation mine.

an important market tool to influence the economy towards production, exports and import substitutes in consumption; the balance of payments has to be improved through its structure, and the best policy regarding exchange rate is a free floating exchange rate system...
The Jerusalem University and Bank of Israel people believe less in the market ability to make the necessary adjustments, at least in an acceptable time in the short run. Some are skeptical about the government ability to reduce spending in the short run... Regarding the exchange rate they are worried about the possibility of a structural change in the economy due to changes in the exchange rate system. The same is true for changes in the price ratio. There are those that claim that almost every change, meaning every devaluation, will be translated into an increase of inflation with no effect on price ratios. The supporters of this approach worry about its impact on economic justice due to sharp increase in the cost of living, and on the distribution of the economic burden that will be caused by the exchange rate that is allowed to free fluctuate...

The first approach (Tel-Aviv University) states that devaluation is a function of recent domestic inflation or that the exchange rate changes are only corrections in the terms of trade due to domestic inflation. The end result of the process is an increase of demand for foreign currency that is putting pressure on the exchange rate that will be devalued eventually. [10] This process can be expected at an environment of inflation caused by excess demand that is fueled by expectations.

The second approach (Jerusalem) states that

10. M.Michaely,"Foreign Trade Regimes and Economic Development: Israel," Columbia University Press, NY, 1975, Ch.5.

devaluation is causing an increase in price of imported inputs and final goods, putting pressure on employers for higher wage demands. [11]

Economists recognize the reasons for inflation as cost-inflation or demand-pull-inflation (from a list of reasons). A belief in one of those reasons will motivate a policy to control inflation. A belief that cost is causing inflation will direct a policy towards controlling cost and consequently inflation; increase in import price due to this approach will affect inflation. The excess demand, by all sectors in the economy, will cause inflation and therefore implies directing policies towards the excess demand by reducing it. A mistake in the diagnosis might cause a terrible effect on the economy. The Bank of Israel acted, for a large portion of the time this study concentrates on, to delay increases in exchange rate in order to control inflation, assuming the Jerusalem approach. (This policy sacrificed the balance of payments, too, to control inflation). [12]

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11. M.Blejer and N.Halevi, "Components of Effective Devaluation and the Domestic Rate of Inflation: The Case of Israel", The Maurice Falk Institute for Economic Research in israel, Discussion Paper.783, Jan.1978,p.1. Published in Journal of Development Economics, 7, 1980, p.117-122.

12. D. Kochav, "Monetary Policy in Action", The Economic Quarterly, Vol.26, No.103, December 1979, p.431.

In the long run the common belief by economists is that exchange rate and inflation are endogenous variables, which means that those two variables are determined by some other exogenous variables.

As can be seen these two approaches were studied by various economists. The importance of the direction the effect takes is crucial for accurate and valid results in research; therefore, the preliminary question should be answered and direction determined. The only limited work on the subject was done by L.Leiderman,[13] whose work is based on quarterly data, from the second quarter of 1969 to the second quarter of 1979, treating this 10-year period as one homogeneous period. The way the research was done, during time of major policy changes and grouping the data into a quarterly basis, is insufficient to determine a direction between the variables. It seems that a monthly study should show important results (Liederman recommends this, too) to understand the last group of years starting 1977 due to very high rates of inflation and very large devaluations.

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13. L.Leiderman, "Dynamic Interaction between Devaluation and Inflation in Israel," The Economic Quarterly, Vol.27, No.107, Dec.1980, p.375-380.

Chapter 4

METHODOLOGY

The objective is to determine the causality relationship, between inflation and exchange rate; therefore, Granger causality tests will be used.

VAR method

The methodology that will be used to test for the relationship between inflation and devaluation will be the Vector Autoregressive (VAR), also known as linear stochastic difference equation, as explained by Thomas J. Sargent, Robert B. Litterman and others.[14] (A model is autoregressive if it has one or more lagged values of the dependent variable among the explanatory variables).

VAR does not depend on economic theories, only on historical data. VAR, as stated by Sargent, is a

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14. T.J.Sargent, "Estimating Vector Autoregression Using Methods Not Based on Explicit Economic Theories", Federal Reserve Bank of Minneapolis Quarterly Review, Summer 1979, p.8-15. Robert B. Litterman, "Techniques of Forecasting Using Vector Autoregressions", Research Department, Working paper No.115, Federal Reserve Bank of Minneapolis, 1979. John Geweke, "Measurement of Linear Dependence and Feedback Between Multiple Time Series", Journal of American Statistical Association, June 1982, Vol.77, No.378.

procedure for analyzing interrelated time series which are mainly intended as an alternative to using structural econometric models as forecasting devices. Alternatives to the structural model have been sought because of increasingly compelling suspicions that the a priori restrictions used in existing structural models are not implied by good dynamic economic theory and that the interpretation and policy conclusion based on those faulty a priori restrictions are worth little...The idea is to estimate VAR with many free parameters and to...deliver estimators with small mean squared errors...these techniques are designed mainly for unconditional forecasting and for compactly summarizing data.[15]

Litterman describes the model as follows: "The statistical model underlying the VAR procedure is a linear dynamic system with an (nx1) vector of outputs, which is generated by a stochastic difference equation. The vector of outputs can include variables thought to be endogenous or exogenous. Each variable is treated as a linear function of its own lagged values and the lagged values of each of the other variables plus a random disturbance".[16]

The VAR with two variables has two equations, where each has the same number of lags and a deterministic component. The variables P and E are treated symmetrically, or the VAR is estimating the following equation:

---

15. Sargent, p.8. For more detail about this contraversy of structural verses nonstructural modeling, see Sargent (1979), Sims (1980) and others.

16. Litterman, p.5.

$$(1)\ P(t) = a + bE(t-1) + \ldots + cE(t-j)$$
$$+ dP(t-1) + \ldots + eP(t-j) + u(t)$$

$$(2)\ E(t) = a, + b,E(t-1) + \ldots + c,E(t-j)$$
$$+ d'P(t-1) + \ldots + e'P(t-j) + u'(t)$$

or (1)-(2) can be written

$$(3)\ P(t) = a + \Sigma\, bE(t-j) + \Sigma\, dP(t-j) + u(t)$$

$$(4)\ E(t) = a' + \Sigma\, b'E(t-j) + \Sigma\, d'P(t-j) + u'(t)$$

where : P(t-j) is the CPI at time t-j,
E(t-j) is the Exchange Rate at time t-j,
u(t) is the residual,
a is a deterministic component,
b,c,d, are coefficients,
j= 1,2,3,4,...,n.

Generalizing those equations into a larger number of variables, we can write:

$$(5)\ Z(t) = \Sigma D(j)\ Z(t-j) + u(t)$$

where: "Z(t) is an (Nx1) vector of variables, including all of the endogenous and all the exogenous variables in the model". [17]

D(j) is an (NxN) matrix of lagged coefficients, Z(t-j) is the lag operator of the variables,

u(t) is a (Nx1) vector of disturbance terms.

D(j) is the matrix of lagged coefficients for the lagged variables P (per cent change in Israel CPI) and E (per cent change in the effective exchange rate). Since the equations are autoregressive, each one has lagged endogenous and exogenous variables explaining the dependent variable. Litterman [18] derives the conditional likelihood function from (5). Let u(t)=e(t), where e(t) is distributed as multivariate normal, [e(t) $\sim$ N(0,S)], with the standard assumption of:

$$\text{mean } E\, e(i) = 0 \text{ for all } i$$

$$\text{Variance } E\, e(i)e(j) = \begin{cases} 0 & \text{for all } i \neq j \\ S_{nxn} & \text{for all } i=j \end{cases}$$

From (5) we can write:

$$Z(t) - [\Sigma\, D(j)Z(t-j)] = e(t)$$

and

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17. Sargent(1979), p.8-9,13.

18. Litterman, p.9-11.

$$P[e(t)|(.)] = \frac{1}{(2\pi)^{n/2} |S|^{1/2}} e^{-1/2 e'(t) S^{-1} e(t)}$$

Where $e'(t) S^{-1} e(t)$ is for multivariate normal distribution of single e(t) and e(t) is a column vector of the residuals that are shocks to different systems. The shocks are not independent and effect each other. ($|S|$ is the determinant of the variance covariance matrix of residuals) The conditional log likelihood for e(t) is

$$L[e(t)] = - n/2 \log 2\pi - 1/2 \log S - 1/2\, e'(t) S^{-1} e(t)$$

and the joint distribution for all e and for t=1...n is the joint log likelihood function:

$$L(.) = -1/N\, n/2 \log(2\pi N)N - N/2N \log |S| - 1/2N \sum_{t=1}^{N} e'(t) S^{-1} e(t)$$

The three parts in the above equation are three numbers that add up to the log(.) which is a scalar. The first term to the right of the equality is fixed, because 2 is fixed. (For maximum likelihood is to minimize the term farthest to the right of the equality sign). The first order condition for maximization of L(.) is:

$$\partial \log L(.)/\partial S = - 1/2\, S^{-1} + 1/2\, N \Sigma\, S^{-1} e(t)e'(t)S^{-1} = 0$$

Multiplying by S we get:

$$-1/2\ I + 1/2\ N [\Sigma\ e(t)e'(t)]\ S^{-1} = 0$$

For this to be 0 we need $[1/N\ \Sigma\ e(t)e'(t)]\ S^{-1} = I$

we call $\hat{S} = 1/N\ \Sigma\ e(t)e'(t)$. This is the MLE of S.

Form a concentrated liklihood function:

$$L^*(.) = -n/2 \log (2\pi) - 1/2 \log |1/N\ \Sigma\ e(t)e'(t)|$$
$$- 1/2N\ \Sigma\ e'(t)\ S^{-1}\ e(t)$$

note that the scalar $1/2N\ \Sigma\ e'(t)\ \hat{S}^{-1}\ e(t)$ gets a trace, or

$$= 1/2N\ Tr\ \Sigma\ S^{-1}\ e(t)e'(t) = 1/2N\ Tr\ \hat{S}^{-1} \Sigma e(t)e'(t) = -N/2$$

$[\ Tr\ NI=N^2$ and $Tr\ I=N\ ]$

and

$$L^*(.) = -n/2 \log(2\pi) - 1/2 \log |1/N\ \Sigma\ e(t)e'(t)| -N/2$$

or

$$L^*(.) = -n/2\log(2\pi) - 1/2\log|\hat{S}| - N/2$$

Then Litterman says "It is a standard result that when the right-hand-side variables are the same in all equations, as they are in the unrestricted VAR which we have in (5), minimization of the log |S| is solved by minimizing the sum of squared residuals in each equation separately. [19] Thus, OLS estimates equation by equation are maximum likelihood estimates conditioned on the initial observations".

Goldfeld comments that the VAR estimate is "not inveriant of the ordering of the equations in the VAR model...it would be mice to know the sensitivity of the estimates to the causal ordering" [20] which motivates a detail study of this ordering below.

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19. Litterman states in footnote: "This is shown for case of fixed regression in Anderson (1958), chapter 8".

20. Stephen M. Goldfeld comments and discussion. (p.156) in Christopher A. Sims "Policy Analysis with Ecnometric models", Brookings Papers on Economic Activity, No.1, 1982, p.107-164.

Granger's test [21]

The Granger test determines the "direction of causality between two related variables and whether or not feedback is occurring". [22] Since this paper is dealing with two variables, according to Granger: " The feedback mechanism can be broken down into two cross spectra, each closely connected with one of the causations." [23]

The general model built by Granger is called: "Instantaneous causality":

$$(6)\quad X(t) + b(0)Y(t) = \Sigma a(j)X(t-j) + \Sigma b(j)Y(t-j) + e(t)$$

$$(7)\quad Y(t) + c(0)X(t) = \Sigma c(j)X(t-j) + \Sigma d(j)Y(t-j) + u(t)$$

where: X(t) is a time series variable (vector) of inflation rate at time t,

Y(t) is a time series variable of devaluation in the effective rate of exchange at time t,

e(t) and u(t) are independent, serially uncorrelated white noise, with finite constant variances.

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21. C.W.J.Granger, "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods", Econometrica, Vol.37, No.3, July 1969, p.424-438.

22. Ibid, p.424.

23. Ibid, p.424.

$E[e(t)e(s)] = E[u(t)u(s)] = 0$ for s not equal to t and $E[e(t)e(s)] = I$ for all s=t.

a,b,c, are coefficients.

The model is called "the simple causal model" if, $b(0)=c(0)=0$, or

$$(8)\ X(t) = \Sigma a(j)X(t-j) + \Sigma b(j)Y(t-J) + e(t)$$

$$(9)\ Y(t) = \Sigma c(j)X(t-j) + \Sigma d(j)Y(t-j) + u(t)$$

The difference between the "instantaneous causality" and "the simple causal model" depends on the speed that information flows through the economy. Granger suggests that if quarterly data is used, "a simple causal model is not sufficient to explain the relationships between variables, while for monthly data a simple causal model would be all that is required". [24]

VAR and Granger models are the same when the model is bivariate as can be seen when comparing equations (3)-(4) and (8)-(9), "The simple casual model".

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24. Ibid, p.427

Sims causality model [25]

C.A. Sims model says the following: "The dynamic analogue is, however, easily testable: if and only if causality runs one way from current and past values of some list of exogenous variables to a given endogenous variable, then in a regression of the endogenous variable on past, current and future values of the exogenous variables, the future values of the exogenous variables should have zero coefficients" [26] "If causality runs from X to Y only, future values of X in the regression should have coefficients insignificantly different from zero, as a group". [27]

Using mathematical notations we get the following:

$$X(t) = \Sigma h(j)Y(t-j) + u(t)$$

$$Y(t) = \Sigma k(j)X(t-j) + v(t)$$

where: $X(t)$ is a time series vector of inflation rate at time t,

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25. C.A.Sims, "Money, Income and Causality", American Economic Review 1972, p.540-552.

26. Ibid, p,541.

27. Ibid, p,545.

Y(t) is a time series vector of devaluation rate at time t (effective exchange rate), and

h(j),k(j), are coefficients.

Sims causality test includes future values. Sims is testing the significance of the effects of inflation on devaluation and visa versa only; therefore, an insignificant result will show h(j)=k(j)=0.

Recently we find criticism on the Sims test. The term cause implies in our contents that Y is causing X, that is, that Y(bar) has some information that is explaining the value of X. Implying this argument to Sims case we can say that "Sims's test is a test of informativeness rather than causality". [28]

Criticism

Causality test models are criticized by economists. One should point out that causality models are not structural models by nature, because they are trying to determine a dependance relationship between variables. Once the dependence relationship is determined, a structural

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28. K.Nagatani, Macroeconomics Dynamics, Cambridge University Press, 1981, p.222. referring to the article by Jacobs, Leamer and Ward, "Difficulties with testing for causation", Economic Inquiry, 1979, No.17, p.401-413.

model can be built.

Sargent points out the following limitations of VAR: "Because these techniques are not based on economic theory, they do not completely substitute for structural models. They cannot appropriately be used to analyze the range of policy interventions that structural models were designed to evaluate. The techniques are not appropriate for conditional forecasting for predicting the behavior of the system under what may be a basic change from the historical pattern in a feedback rule for a policy variable, for example". [29] A different point is made by Jeffrey Sachs. He says, "The central issue in policy simulation is the relation between correlation and causation...Correlation per se may be enough for forecasting, assuming that the future is like the past,..." [30] This is a reaction to Sims artical suggesting that if the policy rules and structure do not change, then one can use VAR for forecasting. Assuming those two to be fixed in a small country is a big risk. One can conclude then that the range of some uses of the VAR technique is controversial.

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29. Sargent(1979), p.8.

30. In Sims(1982), P.158.

A different criticism is about the use of the term cause. Are we looking into models where we have a causality relationship or more information?

Jacobs, Leamer and Ward [31] point out that we might have specification errors, and a slight misspecification can cast doubt on the causality hypothesis. The standard specification error is the ommission of relevent variables, non-linear function form and that the parameters did not remain constant during the time period. [32]

The model used here is one with the variables having the same number of lags. There are no tests of, for example two lags in one variable and three lags in the other, for this kind of model an OLS technique should be used.

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31. R. Jacobs, E. Leamer, M. Ward, "Difficulties with Testing for Causation", Economic Inquiry, July 1979, p. 409.

32. P. Kennedy, A Guide to Econometrics, The MIT Press, Cambridge, Massachusetts, 1979, p.57.

Chapter 5

VAR RESULTS

VARs were estimated with one independent variable and then with two independent variables.

The one variable VAR was of the following kind:

$$(10)\ P(t) = a + \Sigma dP(t-j) + u(t) \text{ and}$$

$$(11)\ E(t) = a' + \Sigma bE(t-j) + u'(t)$$

Equations (10)-(11) are VAR with one endogenous lagged dependent variable. A different model with two independent variables is the model of equations (3)-(4). The initial VAR estimations for (3)-(4) and (10)-(11) were for one equation and one lag, one equation two lags and so forth to one equation with 12 lags or it can be denoted by an order like one lag to be first order, 2 lags second order, etc. The initial VAR estimations for (3)-(4) and (10)-(11) were for one equation one lag up to the twelve equations with 12 lags or a 12th order autoregressive equation.

In using VAR, in addition to determining the constant, a trend, T, (a time variable) was added. "In most multiple regression analyses involving time-series data it is a common practice to introduce the time or trend variable in addition to several other explanatory variables. This is done for the following reasons: 1. Our interest may be simply to find out how the dependent variable behaves over time. 2. Many a time the trend variable is a surrogate for a basic variable effecting the dependent variable". [33] The addition of the trend to the variable improved significantly the results shown by the D.W. statistic or the removal of first order autocorrelation.

One variable models

The first VAR results obtained were for the model, with endogenous lagged variable of equations (10)-(11) alone. The most significant results for P dependent variable (equation 10), as measured by F-tests, are as follows. (For the complete results, see APP B).

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33. D.Gujarati, Basic Econometrics, McGraw-Hill, 1978, p.124-5.

Table 2

VAR results of lagged endogenous CPI.

	equations (equation 1 has 1 lag, equation 2 has 2 lags, etc.)						
	1	2	3	4	5	6	7
F(P)-test	3.49c	2.41	3.33b	2.20c	3.74a	2.82b	2.37b
sig of F	.068	.101	.028	.087	.008	.025	.050
D.W.	1.69*	1.57**	1.96	1.96	1.90	1.94	2.00
A	.265c	.288b	.466a	.474a	.534a	.574a	.619a
P(t-1) B	(1.87)	(2.19)	(3.15)	(2.88)	(3.36)	(3.27)	(3.30)
C	.068	.034	.003	.006	.002	.003	.002
R(sq)	.194	.332	.394	.348	.444	.460	.488
R(sqbr)	.160	.286	.335	.263	.349	.342	.347
d.f.	47	44	41	38	35	32	29

a significant at 1%
b significant at 5%
c significant at 10%
A is the coefficient
B is the T-test
C is the significance of T-test
* significant at 5%
** no decision region at 5% significance
sig is short for significance

Table 2 shows that when estimating an autoregressive model for inflation, with inflation at time t, P(t), as the dependent variable, the first and third to seventh order autoregressive equations are the most significant ones, and the second equation was significant at slightly over 10.0% as measured by the F-test. The D.W. was between 1.90 and 2.00 for the 3rd to 7th equations and a lot less at 1.69 (significant at 5%) and 1.57 (the no decision region at 5%) for the first and second equations.

In all cases (1 to the 7 order autoregressive equations) the coefficient for the first lag in each equation had the most significant T-test and the largest positive coefficient, which indicates that a large portion of 1% increase in price is adjusted on the average at the first lag alone.

In addition (from app B), in the equations of order two to seven, the second lag in all of them had a negative and in most cases not significant (T-test) coefficient. The sixth and seventh order equations were significant at more than 6%, which indicates that the second lag is not as important. A constant, more than 2 in value, was significant under 10% at the first to the 4th autoregressive order. The trend was significant under 10% at the 1 to 3 autoregressive order with relatively small values.

The VAR process, when applied to the exchange rate as the dependent variable (equation 11), had the only significant result at the first equation with one lag showing the following:

$$E(t) = .998 + .164(T) - .180E(t-1)$$

(T-test)	(1.05)	(5.68)	(-3.42)
sig of T-test	.298	.0	.0013

R(sq)=.4697 R(sqbr)=.4471 SEE=2.93 D.W.=2.12

F(E)=11.73 or .0013 sig

These results indicate that the exchange rate with a one month lag has an inverse effect on the latter month. This effect is significant but does not have a large coefficient.

The time trend (T) is very significant and positive. One should notice that the exchange rate does not behave as a random walk.

Although it is most interesting to look at the endogenous variable explaining the dependent variable, it will be of little help explaining the relationship between inflation and the exchange rate. For the determination of the relation we need the cross lagged coefficients.

PRICE AND EXCHANGE RATE MODEL

When incorporating the two variables, price and exchange rate, into VAR process, the criteria determining direction of causality will be the significance of the F-test results from equations (3)-(4). The F-tests are unique because "These test the significance of the block of lags associated with each of the variables". [34] (Only F-tests at under 10% significance will be considered). For example, in (3) where P (percent change in CPI) is the dependent variable, the F-test for the block of lags of E (exchange rate) should be significant in order to conclude that E is causing P. In case the F-test for (E) in (3) and the F-test for (P) in (4) are both significant, one can conclude that there is causality in both directions regardless of which F is larger. Although the causality to both directions might appear, a significant difference between two significant F-tests will indicate a strong intensity in favor of the more significant one. [F(P) in (3) and F(E) in (4) are the autoregressive lags of the dependent variable]. The estimates that will be produced will tell, based on historical data, which variable explains better the other one, using a different number (length) of lags.

Once the significant equations were determined, one will be able to determine the sum of the coefficients of the independent variable within n lags, or we capture as close to 1% of a 1% change in a dependent variable caused by all the independent variables.

Exchange rate as dependent variable

Using the VAR equations (3)-(4) for six equations with autoregressive orders of one to six, the best results appeared on the 2nd, 3rd and 4th equations when the Effective Exchange Rate (equation 4) was the dependent variable (Table 3). The criteria for causality determination is by an F-test of a block of lags.

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34. RATS Manual, p.10-3.

Table 3

results for % change in E, dependent variable.

		equations with: 1 lag	2 lags	3 lags	4 lags	5 lags
	A	.298	.374 c	.290	.292	.242
P(t-1)	B	(1.57)	(1.72)	(1.25)	(1.22)	(.873)
	C	.122	.093	.218	.231	.389
	A		.329	.563 b	.549 c	.612 c
P(t-2)	B		(1.66)	(2.23)	(1.99)	(2.01)
	C		.104	.032	.055	.053
	A			-.315	-.336	-.483
P(t-3)	B			(-1.46)	(-1.18)	(-1.49)
	C			.151	.246	.145
	A				.365	.450
P(t-4)	B				(1.56)	(1.36)
	C				.127	.183
P(t-5)	A					-.236
	B					(-.914)
	C					.368
	A	-.171 a	-.325 b	-.324 b	-.286 c	-.292
E(t-1)	B	(-2.98)	(-2.27)	(-2.06)	(-1.73)	(-1.57)
	C	.0046	.028	.046	.091	.125
	A		-.129 c	-.104	-.20	-.273
E(t-2)	B		(-1.88)	(-.672)	(-1.20)	(-1.45)
	C		.067	.505	.239	.158
	A			-.079	-.273	-.300
E(t-3)	B			(-1.04)	(-1.63)	(-1.59)
	C			.304	.111	.121
	A				-.058	-.144
E(t-4)	B				(-.73)	(-.736)
	C				.470	.467
	A					-.024
E(t-5)	B					(-.267)
	C					.791

CONST	A	.067	-.878	-.129	-1.19	-.779
	B	(.053)	(-.659)	(-.087)	(-.748)	(-.445)
	C	.958	.513	.931	.459	.659
TREND	A	.136 a	.139 a	.158 a	.183 b	.260 b
	B	(3.89)	(3.29)	(2.95)	(2.47)	(2.54)
	C	.0003	.002	.005	.018	.016
R(sq)		.430	.407	.432	.492	.475
R(sqbr)		.393	.337	.328	.357	.282
D.W.		2.28	1.97	1.90	1.95	1.84
F(P)		2.48	4.12 b	3.77 b	2.64 b	2.09 c
sig F-test		.122	.023	.018	.050	.094
F(E)		8.87 a	3.17 c	1.52	1.25	.917
sig F-test		.0046	.052	.226	.309	.483
n		50	48	46	44	42
d.f.		46	42	38	34	30
Sum P(t-j)			.703	.538	.870	.585
Sum E(t-j)			-.454	-.507	-.827	-1.033

a significant at 1%
b significant at 5%
c significant at 10%
A is the coefficient
B is the T-test
C is the significance of the T- or F-test

The most significant block of lags (F-test) showing P explaining E is at the third order autoregressive equation with three lags, F(P) = 3.77 or .018 significance. At the second and fourth order autoregressive equations the results are still significant under 5% but slightly less than the third lagged equation. These three cases indicate that the change in CPI is causing changes in the exchange rate and not the other way around, strictly based on the F-tests.

The coefficients of the third order equation are significant in a few instances, like P(t-2)=.563 significant at 5% and E(t-1)=-.324 again significant at 5%. In addition the time trend (T=.158) is significant and positive. Similar results are obtained for the fourth order equation with significance at 10%.

The total sum of the price coefficients is the largest in the fourth equation and is equal to .870, which means that a 1% increase in price will have an increasing cumulative effect over 4 months of .870% on the average, on E. Is this significantly different from one? The T-test for the cumulative inflation coefficients is .955 with 34 degrees of freedom; this is less than the table value and we accept the null hypothesis that the cumulative sum is statistically not significantly different than one at 5% or better.[35]

The result at the fourth order has an F statistic significant at 5%. The P(t-1) and P(t-3) coefficients are not significant, and eliminating them will give the sum of .914 for P(t-j) with the significance of the T-test increased to .127. The price coefficients are statistically more significant than the exchange rate coefficients.

The equations in table 3 with 2, 3, 4 and 5 lags (when E is the dependent variable) have a large coefficient in the second lag, P(t-2), significant level ranging from 3.2 to 10.4 per cent (table 4).

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35. Variance for the sum P(t-j) for j=1..4 is Var P(t-1) +...+ Var P(t-4) + 2 { Cov [P(t-1)P(t-2)] + Cov [P(t-1)P(t-3)] +...+ Cov[P(t-3)P(t-4)]} that adds up to .0575 + .0761 + .0813 + .0544 + 2{ -.0286 -.0051 -.0306 -.0272 + .0106 + .0143 } = .1361. Test the null hypothesis:

Ho: Sum of P(t-j) = 1
H1: Sum of P(t-j) not = 1

$$t = \frac{\text{estimated sum of } P(t-j) - 1}{\text{S.E. of sum of } P(t-j)} = \frac{.870 - 1}{.1361} = .955$$

We accept Ho (Ho<than table value at 5%) that Ho is statistically not different than 1.

Table 4
Second lag CPI coefficients and significance (from table 3).

Equation with the following # of lags	coefficient of second lag from table 3	sig of T-test	T-test
2	.329	.104	1.66
3	.563	.032	2.23
4	.549	.055	1.98
5	.612	.053	2.01

Table 4 indicates that the second lag is of some importance and that a large portion of the adjustment takes place in the second lag.

For the exchange rate as the dependent variable explaining the endogenous behavior, we find that the effect of lagged exchange rate on the exchange rate itself (table 3) is significant only for the first and second equations with one and two lags (F-test).

For the second order lagged equation results (Table 3, 2 lags), the F(P)=4.12 is larger than F(E)=3.17, where at the first order equation the opposite is true. The results indicate that there is an inverse belief that once a devaluation took place, another devaluation will not occur the following month.

Additional results are noticed from table 3: the signs of the exchange rate coefficients are always negative, an indication that might suggest that there is no reason to believe that once an adjustment in exchange rate was made another one will follow. The first lagged exchange rate coefficient is always negative, largest and the most significant, T-test ranging from .0046 to .091 level of significance between the first and the fourth order.

CPI as dependent variable

The results when the price (CPI) is the dependent variable (equation 3) point out the following:

1. The F-test for exchange rate in this equation is significant only for the first order equation and somewhat significant in the sixth order equation:

	P(t) = 2.18 +	.041(T) +	.291P(t-1) +	.142E(t-1)
T-test	(2.56)	(1.74)	(2.31)	(3.71)
sig T-test	.013	.087	.025	.0006

R(sq)=.3796 R(sqbr)=.3391 SEE=2.17 D.W.=1.70*

F(P)=5.34 or .0253 sig

F(E)=13.76 or .00056 sig

n=50 d.f.=46

* critical D.W. for 5% significance is dl=1.49 and du=1.63

This implies that with one lag 1% change in the exchange rate alone will increase P by .142% on the average, relatively a small amount coming from the exchange rate.

In the sixth autoregressive order equation F(E)=2.15 (or .080 sig) and F(P)=3.69 (or .0087 sig), where the exchange rate does not dominate the results.

The insignificance of the results for equations of order 2 to 5 is somewhat surprising, since a large number of economists believe that the price of imported goods has a very important effect on the price level (or that causality is from exchange rate to price). Therefore, a policy of controlling inflation by controlling exchange rate was adopted for some time. This policy of controlling inflation by controlling the exchange rate was letting the formal exchange rate rise by a relatively small amount of 5% a month, when the price rise was substantially larger. This attempt did not reduce inflation in the subsequent months. Eventually after about a year the attempt was abolished (mid 1981 to mid 1982).

2. The F-test for CPI (CPI explaining their own behavior) is significant in all the equations tested (ranging from .0043 to .068 significance, for first to the seventh order equations).

3. The coefficients of the CPI in the first lag in all seven equations are positive, relatively large (ranging

from .291 to .718) and significantly below 1%, besides the first equation that is 2.5%.

4. The most interesting equation is the fifth of order one, where the sum of the (CPI) coefficients is .955 and F(p) is 4.35 (or a .0043 sig), strongly implying that a 1% change in CPI at the end of five months already captured back .955% . This is consistent with the results obtained using equation (10).

The results obtained indicate that the causality relationship between per cent change in CPI and per cent change in exchange rate is from the first to the second. These results are consistent with results obtained by using quarterly data.

Chapter 6

QUARTERLY RESULTS

A study was done to determine the causality relationship between inflation and exchange rate in Israel (using per cent change in CPI and per cent change in the effective exchange rate) by L. Leiderman. Leiderman's study is on quarterly data for the period between the second quarter of 1969 to the second quarter of 1979, applying Sims and Granger causality tests. The study indicated that the causality direction is from inflation to exchange rate. [36]

The grouping of the end of month data into quarters can be done in different ways:

a. Q1, starting with the ends of January, April, July and October.

b. Q2, starting with the ends of February, May, August and November or

c. Q3, starting with the ends of March, June, September and December, and

d. Q-ave, following Q3 and averaging the three months.

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36. Leo Leiderman, "Dynamic Interaction between Devaluation and Inflation in Israel", <u>The Economic Quarterly,</u> Vol.27, No.107, Dec 1980, p.379.

The usual ordering of the year into quarters follows the third option, Q3, but I don't see why it should be the case, when in general the division of calendar time into quarters is really an arbitrary process. If policy variables are cyclical or corrective and are included in a model, they will have an effect on the results, like the Cost of Living Allowance (COLA) in Israel. For the last few years the COLA is paid every quarter, when the quarter is Q1 from the list above, with the actual payment being made a month later or following quarter Q2 from the above list. (The decision to pay COLA is for January. The actual payment as part of the wage is received by the public in the pay of Febuary 1. Wages are paid once a month).

The grouping of the months into quarters was done in different ways, for Q1, Q2, Q3 and Q(ave) from the list above. VAR results were as follows:

When Q1, Q3 and Q(ave) were used, no significant results were obtained, when applying up to three lags. (No more than three lags were tried due to lack of degrees of freedom; for three lags the d.f. were already utilized).

When Q2 was used it appeared that the only significant result was the following one:

$$E(t) = 2.68 + 2.53(T) - .005P(t-1) - .690E(t-1)$$

T-test	(.643)	(3.97)	(-2.55)	(-2.48)
sig T	.534	.002	.027	.031

R(sq)=.6623 R(sqbr)=.5702 SEE=6.05 D.W.=1.66

F(P)=6.50 or .027 sig

F(E)=6.15 or .031 sig

n=15 d.f.=11

The results obtained had a relatively low D.W. The critical D.W. for the indecision zone with n=15 at 5% is dl=.95 and du=1.54. For 1%, the indecision zone is dl=.70 and du=1.25, which implies that we still have a sufficient result without first order serial correlation. Any other result had F-test significant at 20% or more, which is not acceptable.

The results indicate that inflation does have an effect on the exchange rate, and the coefficient, P(t-1), is very very small, negative and significant. It is impossible to conclude more from these results.

The results obtained indicate that a more careful monthly data study was needed. The high rate of inflation observed for the years studied justifies a monthly investigation. A comparison of the results obtained here to the results obtained by Liederman is not possible.

Leiderman reports results for a 4 lagged equation; a fourth order equation is not possible to obtain here due to the lack of degrees of freedom. One should note that Liederman ignores policy changes, and he acknowledges this omission. This reduces the ability to compare results even farther.

Chapter 7

COST OF LIVING ALLOWANCE [37]

The Israeli economy for a long period of time adopted a Cost of Living Allowance (COLA) policy, that is incorporated into the system and became part of it. Since the COLA policy indicates in advance when COLA will be paid, one can expect an effect on the population behavior. The estimates obtained before will change due to the COLA policy. Given the regularity of the COLA payments, incorporating the information that COLA policy supplies is of importance, in order to get the estimates of the equations with prices and exchange rate. Since COLA is a policy that appears in precise regularity (see table 5 below, column D1, 79-4 to 82-1), the way to test for its effect is through a dummy variable.

The addition of the dummy variable to the VAR process is in the form of an additional variable to the original price and exchange rate. This dummy variable gets the value 1 at the appropriate locations and 0 elsewhere. The dummy

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37. Based on O.Leviatan, "The Development of The Cost of Living Allowance and Other Wage Items", The Economic Quarterly, Vol.29, No.115, Dec.1982, p.349-357. and O.Leviatan, "The Meaning of the New Cost of Living Allowance Agreement", The Economic Quarterly, Vol.30, No.116, April 1983, p.524-526.

variable is treated like any other variable, including its lag distribution, in order to obtain its lagged effect on the dependent variable. The dummy will change the intercept value obtained from the constant, which will imply a change in the underlying effect. In the cases of the deterministic model and the non-deterministic model, it will imply that people are able to anticipate a large change and behave accordingly again by changing the underlying effect.

We start with a short description of COLA policy in Israel.

The cost of living allowance (COLA) in Israel started after the second World War, with the intention of maintaining the real income as the main reason. The agreement for cost of living allowance is based on 5 principles:[38]

a. Frequency of payment of COLA - minimum number of months allowed between one allowance and another.

b. The base for payment of COLA - the per cent of price rise that beyond it will require an allowance (3% until Jan.75, and 5% since).

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38. Ibid, p.350.

c. The base index payment - the base index point that the allowance payment will start to maintain real income.

d. Compensation rate - the per cent of pay from the increase in prices (100.0% from the creation of the state to January 1975, 70.0% until October 1979, 80.0% until July 1982. In 1982 it was changed to the following formula: 80% if in three consecutive months the CPI cumulative increase is by less than 20%, 85% if in three consecutive months the CPI cummulative increase is by 20%-30%, and 90% if the CPI increase is by 30% or more).

e. Maximum pay - the maximum level of income that will become a ceiling to gain the allowance listed in a to d.

Cost of living allowance is not the only source of increase in income; COLA did not maintain the real income. There are other components that can be considered income like automatic pay increases for car, phone, vacation, etc. The cost increases depend on the cost of those services and together with the COLA maintained real income. [39]

The principles listed above have a bearing on this paper. During the period of this study, October 1977 to January 1982, the actual number of months between one

39. Ibid, p.354.

allowance of the cost of living and another was 3 months or even more frequent in some cases like July, August and September of 1979, or every two months in other cases with all kinds of advances to a large previous increase in the cost of living. A clear distinction will be made between COLA that is fully anticipated (known in advance due to agreements between union and government, negotiated well in advance) and unanticipated COLA that are compensatory for unanticipated large price increases that were recent.

Since the COLA are either anticipated or unanticipated, one can study them carefully to determine how they effect price and exchange rate. Farther, if there is an effect an indication about its nature can be determined too.

The period this paper is investigating had anticipated (deterministic-D1) and unanticipated (nondeterministic-D2) COLA as shown in table 5.

Table 5

COLA payments dates between August 1977 and January 1982

YEAR	deterministic D1	non-deterministic D2
77-10	x	
78- 1		x
78- 4	x	
78-10	x	
79- 1		x
79- 2		x
79- 3		x
79- 4	x	
79- 7		x
79- 8		x
79- 9		x
79-10	x	
80- 1		x
80- 2		x
80- 3		x
80- 4	x	
80- 7	x	
80-10	x	
81- 1	x	
81- 2		x
81- 4	x	
81- 7	x	
81-10	x	
82- 1	x	

x indicates a COLA payment at this month.
Source: Ibid, p.352.

Deterministic COLA

The additional anticipated COLA information should have an effect on the causality relationship that was developed before between inflation and exchange rate and some additional explanatory power on the behavior of the dependent variables.

The original model (3)-(4) was expanded to equations (12)-(14) adding the policy variable, D1 (which takes account of anticipated COLA policy from table 5), in the form of a dummy variable assuming 1 for periods that an anticipated COLA was in place and 0 elsewhere. The dummy variable effects the intercept and the slope. Equations (12)-(13) will incorporate the intercept only and will have the following form:

$$(12)\ P(t) = a + \Sigma bE(t-j) + \Sigma dP(t-j) + \Sigma cD1(t-j) + u(t)$$

$$(13)\ E(t) = a' + \Sigma b'E(t-j) + \Sigma d'P(t-j) + \Sigma c'D1(t-J) + u'(t)$$

When: With policy D1=1 in (12) or (13) we get a correction to the intercept (a+c) instead of a.

Without the policy D1=0, we follow equations (3)-(4).

A farther correction for the effect of the policy on the intercept and slope in (12)-(13) will become:

$$(12') \quad P(t) = a + \Sigma bE(t-j) + \Sigma dP(t-j) + \Sigma cD1(t-j) + \Sigma fD1xE(t-j) + \Sigma eD1xP(t-j) + u(t)$$

(13') similarly to (12')

Where: f,e will be the correction to the coefficients determining the slopes. For no policy, D1=0, we get equations (3)-(4) and with the policy, D1=1, the intercept will be (a+c) and the slopes will change to (b+f) and (d+e).

In addition VAR generates an equation with a Dummy, D1, as the dependent variable, (equation 14); that is the conditional probability that an event will occur or that the coefficients b", d" and c" will indicate what is their probability effect on the policy, D1. (More detail in: Policy as the dependent variable).

$$(14) \quad D1(t) = a'' + \Sigma b''E(t-j) + \Sigma d''P(t-j) + \Sigma c''D1(t-j) + u''(t)$$

(The effect of the policy, D1, on the intercept and slope will be reported when significant).

Exchange rate as the dependent variable.

The most significant results were obtained when exchange rate was the dependent variable and the policy as an intercept, Table 6:

Table 6
VAR results for the per cent change in E as the dependent variable explained by P and D1.

		equation with: 1 lag	2 lags	3 lags	4 lags	5 lags
P(t-1)	A	.173	.170	-.131	-.188	.072
	B	(.914)	(.755)	(-.56)	(-.77)	(-.238)
	C	.366	.454	.576	.444	.813
P(t-2)	A		.422 b	.970 a	1.052 a	.954 a
	B		(2.16)	(3.90)	(3.60)	(2.90)
	C		.036	.0004	.001	.007
P(t-3)	A			-.411 b	-.568 c	-.399
	B			(-2.03)	(-1.78)	(-1.01)
	C			.050	.084	.320
P(t-4)	A				.459 c	.221
	B				(1.98)	(.547)
	C				.056	.589
P(t-5)	A					.034
	B					(.106)
	C					.916
E(t-1)	A	-.195 a	-.230	-.187	-.099	-.116
	B	(-3.47)	(-1.56)	(-1.25)	(-.574)	(-.521)
	C	.0C1	.125	.219	.570	.606
E(t-2)	A		-.091	-.144	-.232	-.183
	B		(-1.32)	(-.939)	(-1.24)	(-.823)
	C		.194	.354	.225	.418
E(t-3)	A			-.127 c	-.331 c	-.286
	B			(-1.75)	(-1.92)	(-1.31)
	C			.088	.064	.202
E(t-4)	A				-.021	-.057
	B				(-.281)	(-.283)
	C				.780	.779
E(t-5)	A					.022
	B					(.260)
	C					.796

D1(t-1)	A	2.48 b	2.86 b	2.65 c	3.72 b	4.09 b
	B	(2.24)	(2.32)	(1.85)	(2.43)	(2.20)
	C	.030	.025	.073	.021	.037
D1(t-2)	A		-.115	-2.58 c	-1.72	-1.43
	B		(-.096)	(-1.80)	(-1.06)	(-.666)
	C		.924	.080	.297	.511
D1(t-3)	A			-2.12	-1.07	-.327
	B			(-1.51)	(-.578)	(-.141)
	C			.139	.567	.888
D1(t-4)	A				.435	1.16
	B				(.271)	(.547)
	C				.788	.589
	A					2.02
D1(t-5)	B					(1.06)
	C					.299
CONST	A	.309	-.729	.146	-1.09	-1.50
	B	(.253)	(-.572)	(.112)	(-.76)	(-.850)
	C	.802	.571	.911	.453	.404
TREND	A	.137 a	.112 b	.180 a	.165 b	.141
	B	(4.08)	(2.66)	(3.78)	(2.50)	(1.37)
	C	.0002	.011	.0006	.018	.182
R(sq)		.487	.4854	.6017	.6630	.6491
R(sqbr)		.442	.3954	.4879	.5170	.4246
D.W.		2.06	1.93	1.90	2.00	1.91
F(P)		.835	3.55 b	6.01 a	4.17 a	2.40 c
sig F(P)		.366	.038	.002	.008	.065
F(E)		12.07 a	1.46	1.38	1.35	.51
sig F(E)		.001	.244	.263	.274	.761
F(D1)		5.03 b	3.03 c	4.96 a	3.80 b	2.48 c
sig F(D1)		.030	.059	.006	.013	.059
n		50	48	46	44	42
d.f.		45	40	35	30	25
Sum P(t-j)			.592	.428	.755	.882
Sum E(t-j)			-.321	-.458	-.683	-.620
Sum D1(t-j)			2.75	-2.05	.528	5.51

A the coefficient
B is the T-test
C the significance of the T-test
a significant at 1%
b significant at 5%
c significant at 10%

As seen from the table above the F-test is most significant in the 2nd, 3rd and 4th equations, where the F-test significance is 3.8%, .2% and .8% respectively, which is an improvement from the previous results (table 3) when we did not incorporate the COLA policy.

Table 6 shows that the price coefficient of the second lag in each equation (2nd, 3rd and 4th) is by far larger and more significant (T-test) than when the policy was not part of the model. The third equation had a large and most significant coefficient, .970, compared to .563 when D1 was not part of the model, the fourth equation had a coefficient that is even larger, 1.052 (T-test sig=.001). We find a clear indication that the anticipated policy is of utmost importance.

The coefficient of the dummy variable is "the differential intercept coefficient because it tells by how much the value of the intercept term of the category that receives the value of 1 differs from the intercept coefficient of the base category". [39]

When COLA is part of the model, we find that the policy has a strong influence on the intercept; the F-test

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39. Gujarati, p.291.

is very significant, .6% with 3 lags. The third order equation shows that the COLA policy coefficient of D1(t-1) is very large, 2.65, and significant under 10% (T-test=7.3%) or that the policy will have an effect on the intercept. A month later, D1(t-2) will have a -2.58 effect on the intercept, almost a full reversal from the first lag with a similar level of significance, (T-test=8.0%). The D1(t-1) intercept shows significance at all other lags, too. In the second and fourth equations the effect of the policy is not countered at any time later and shows a significant intercept. Using the value of D1(t-1)=2.86 in equation 2, as an example, it implies that there is a new constant or that the average underlying effect on E coming from COLA policy is 2.86 during the months COLA is paid. The time trend shows a positive trend in all the equations and in most cases similar in magnitude to the results in table 3.

When incorporating D1 that is acting on the slopes in equations (12')-(13'), the results are not significant and all statistics are unacceptable.

The above policy results together with the price coefficients are the most significant in explaining the exchange rate. The interpretation of the results might be that the COLA policy effects the exchange rate by having a large underlying devaluation level in the system expressed by the intercept. An explanation of this behavior lies in the adjustment the public makes to the rates and large devaluation in the years of this study. The wage is paid once a month at the beginning of the month, with many people converting a large portion of their income into dollars and converting the dollars back to Shekels during the month as a function of their spending or simply paying in dollars. The tendency of the population in general is to save, with government encouragement to do so through various attractive savings programs that maintain the real value of the savings and even more. When people convert back into Shekels, still a certain amount is kept in foreign currency as savings to maintain a real rate of return; the law permitted this kind of practice at the time of this study. One should notice that business to a large degree behaves in a similar way. In addition we find many luxury items for sale priced in dollars; this practice is commonly used by the public and business community as well. Every three months, since the beginning of 1980, wage earnings due to COLA payment increased significantly in nominal terms, especially in the month COLA was paid. If the practice to convert and convert back is utilized, at the time of a COLA compensation an increase in the demand for dollars or the devaluation of the

Shekel will be noticed, through a significant value of D1(t-1), which is the intercept or the underlying devaluation rate. In addition, an increase of demand for imported goods a short time before the COLA payment (probably a month) is expected. The effect of increased prices on exchange rate is most significant and largest at the second lag. The slight reduction in significance at the other lags is due to the fact that the policy variable, the dummy of the fully anticipated COLA, is significant. The decline in significance in P(t-j)'s is expected; i.e., there is a "direct" effect without going through P(t-j).

The results clearly indicate again the influence of prices on the exchange rate together with COLA policy, or that the causality relationship is determined from inflation to the exchange rate.

A comparison of the F-test and R(sq) results with and without COLA shows the following:

Table 7

F-test results when exchange rate is the dependent variable with and without COLA policy (from tables 3 and 6)

	equation with:							
	2 lags		3 lags		4 lags		5 lags	
	A	B	A	B	A	B	A	B
F(P)	4.12	3.55	3.77	6.01	2.64	4.17	2.09	2.40
sig	.023	.038	.018	.002	.050	.008	.094	.065
F(E)	3.17	1.46	1.52	1.38	1.25	1.35	.917	.510
sig	.052	.244	.226	.263	.309	.274	.483	.761
F(D1)		3.03		4.96		3.80		2.48
sig		.059		.006		.013		.059
R(sq)	.407	.485	.432	.602	.492	.663	.475	.649
R(sqbr)	.377	.395	.328	.488	.357	.517	.282	.425

A is the column without the policy variable
B is the column with the policy variable
sig refers to the F-test significance of a block of lags.

Table 7 shows that the equation with 3 lags dominates the rest. The addition of the COLA policy shows stronger than in the rest the significance of the effect of prices on the exchange rate together with the COLA policy. R(sq) and R(sqbr) improved, too, which implies that the policy was an important addition to explain the behavior.

CPI as dependent variable

The set of equations where the per cent change in CPI was the dependent variable, explained by the exchange rate and the policy, D1 (equation 12 intercept effect), showed no real improvement, the significant equation was again with one lag:

P(t) =	2.17 +	.041(T) +	.296P(t-1) +	.143E(t-1)	-.094D1(t-1)
T-test	(2.52)	(1.72)	(2.22)	(3.62)	(-.121)
sig T	.015	.091	.031	.0007	.904

R(sq) = .3798 R(sqbr) = .3247 SEE = 2.19 D.W. = 1.71

F(P) = 4.93 or .031

F(E) = 13.14 or .00073

F(D1) = .014 or .904

n=50 d.f.=45

Correlation Matrix

	CPI	E.R.	D1
CPI	1	.0857	.3916
E.R.	.0857	1	-.1078
D1	.3916	-.1078	1

The equation shows that the constant is not effected by the policy and is almost the same size as before (2.18); with similar significance the same is true for all other coefficients.

The R(sq) is relatively small compared to previous results. The D.W. at 5% level of significance is close to the upper limit (du), the indecision areas (critical dl=1.42 and du=1.67). The correlation between the CPI and D1 is positive and moderate (.3916). The cross correlation is very small, only .0983 (when trend, constant and the lags are included). There is an improvement in the explanatory power of the autoregressive prices on themselves, by improving the significance of the results obtained before, as measured by F-test and T-test, the coefficients were larger too. The addition of D1 to determine an effects on the slope did not materialize significant results.

The F-test for E was significant for the equation with six lags too, with a very low D.W.=1.41 that is not acceptable for first order serial correlation, the dominant variable was the CPI, F(P), explaining its own behavior.

F(P) = 6.63 or sig .00056

F(E) = 3.43 or sig .0172

F(D1) = 3.83 or sig .0104.

Policy as the dependent variable

The set of equations where the policy, D1, was the dependent variable have a unique and somewhat different interpretation in econometric work; the estimate of the D1 dummy dependent variable "can be interpreted as the conditional probability that the event will occur given Z(t); that is, $Pr[D1(t)=1|Z(t)]$".[41] The results obtained were the following:

41. D.Gujarati, Basic Econometrics, McGraw-Hill Company, 1978. p.313.

Table 8

VAR results when COLA policy,D1, the dependent variable explained by P and E

		equation with: 1 lag	2 lags	3 lags	4 lags
	A	.002	.009	.007	.012
P(t-1)	B	(.088)	(.389)	(.255)	(.469)
	C	.930	.692	.800	.642
	A		-.024	-.014	-.049
P(t-2)	B		(-1.15)	(-.484)	(-1.51)
	C		.256	.631	.141
	A			-.049 b	.257
P(t-3)	B			(-2.06)	(.731)
	C			.047	.470
	A				-.064 b
P(t-4)	B				(-2.51)
	C				.018
	A	.006	.047 a	.061 a	.031
E(t-1)	B	(.846)	(2.94)	(3.50)	(1.65)
	C	.402	.005	.001	.110
	A		.014 c	.015	.023
E(t-2)	B		(1.88)	(.819)	(1.13)
	C		.067	.418	.266
	A			-.0015	.007
E(t-3)	B			(-.176)	(.377)
	C			.861	.709
	A				-.009
E(t-4)	B				(-1.12)
	C				.272
	A	-.332 b	-.515 a	-.441 b	-.562 a
D1(t-1)	B	(-2.33)	(-3.85)	(-2.63)	(-3.33)
	C	.024	.0004	.012	.002
	A		-.608 a	-.643 a	-.697 a
D1(t-2)	B		(-4.64)	(-3.85)	(-3.91)
	C		.00003	.0005	.0005

	A			.175	-.188
D1(t-3)	B			(1.07)	(-.923)
	C			.290	.363
	A				-.297
D1(t-4)	B				(-1.68)
	C				.104
CONST	A	.100	.157	.254	.411 b
	B	(.630)	(1.14)	(1.67)	(2.61)
	C	.531	.261	.103	.014
TREND	A	.006	.004	.005	.013 c
	B	(1.44)	(.894)	(.920)	(1.86)
	C	.156	.367	.363	.072
R(sq)		.149	.5034	.5680	.6469
R(sqbr)		.074	.416	.4446	.4939
SEE			.324	.321	.302
D.W.		2.32	1.92	2.13	2.08
F(P)		0	.663	1.99	2.13
sig		0	.521	.134	.101
F(E)		.715	4.52 b	4.32 b	2.02
sig		.402	.017	.011	.116
F(D1)		5.42 b	14.20 a	11.23 a	6.65 a
sig		.024	.00002	.00002	.0006
n		50	48	46	44
d.f.		45	40	35	30

A the coefficient
B is the T-test
C significance of the T-test
a significant at 1%
b significant at 5%
c significant at 10%

The results obtained show that "each slope coefficient gives the rate of change in the conditional probability of the event occurring for a given unit change in the value of the explanatory variable", [42] which means that if E(t-1)=.047 holding all other factors constant, the probability of exchange rate effecting policy at the first lag is .047%.

The results in table 8 indicate that the COLA policy has a significant exchange rate variable when three lags are applied. The first lagged exchange rate, E(t-1), coefficient implies that the probability of this lag effecting policy is .061%. The same equation has a significant P(t-3) coefficient that is negative and small implying the opposite. The significant results of the second equation is that policy will be effected by .061% for the cumulative exchange rate coefficients. These results indicate that although the range of the expected value of D1 given exchange rate (E.R.) is between 0 and 1, $[0 < Exp(D1|E.R.) < 1]$, we are closer to 0 or that the effect of exchange rate on policy is very small. The significant coefficients for P are negative and small, too.

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42. Gujarati, p.318.

The intercept coefficient at the 3rd autoregressive order equation shows a significant result with the policy, (D1=1), where the significant lags, [D1(t-1)+D1(t-2)], reduce the intercept by -1.084 or that when COLA is paid, the constant becomes significant. This will imply that the public does not expect another COLA in the two months following a COLA payment. When considering the constant obtained and allowing the significance to slip to 10.3%, the new intercept will be -.830.

Expectations

The non-deterministic variable is not totally unanticipated. The decision to pay some kind of compensation was not done in an unknown environment to the public. As a matter of fact, the negotiations for the unanticipated COLA are taking place all along and the public is aware of them. The public does not know the critical date the unanticipated COLA will be paid and the amounts, until very close to the date itself, but at times the public knows the date and the amount a couple of weeks in advance. Empirically it suggests that when investigating the effect of unanticipated COLA, one should find if it has a "direct effect" or an expected effect.

The "direct effect", denoted by D2, on P and the exchange rate, results when adding D2 into the estimated equations.

The equations that will test for the "direct effect" are as follows:

(15) $P(t)= a + \Sigma bE(t-j) + \Sigma dP(t-j) + \Sigma cD2(t-j) + u(t)$

(16) $E(t)= a' + \Sigma b'E(t-j) + \Sigma d'P(t-J) + \Sigma c'D2(t-j) + u'(t)$

(17) $D2(t)= a'' + \Sigma b''P(t-j) + \Sigma d''E(t-j) + \Sigma c''D2(t-j) + u''(t)$

The expected effect, denoted by D2HAT, is calculated in the following manner: once (15)-(17) were obtained, the VAR process will report the residuals, u"(t)HAT, that those equations generate too, in three different columns associated with each variable. (This part of the computer print out is not reported.) Since unanticipated COLA is assumed to be a variable not known in advance, the residuals and the dummy both can be considered noise in the system. One can find the total noise by adding them up. In our case, from (17), D2(t) - RD2(t), where RD2(T) is the column of residuals generated only for the D2(t) variable, we get a new variable, D2HAT. D2HAT by the way of calculation is the predicted value of D2. D2HAT will become then a measure of expectations that is looking backwards, or an "adaptive" type, because the revision of behavior is based on the most recent error. This expectation can be considered "rational" as well because the large cumulative error holds information of cumulative loss and therefore an adequate belief that in the near future an adjustment to wages will occur, as it always did, given the policy of adjustments in COLA every three months.

The three equations that will be tested are as follows:

$$(18)\quad P(t) = a + \Sigma\, bE(t-j) + \Sigma\, dP(t-j) + \Sigma\, cD2HAT(t-j) + v(t)$$

$$(19)\ E(t) = a' + \Sigma b'E(t-j) + \Sigma d'P(t-j) + \Sigma c'D2HAT(t-j) + v'(t)$$

$$(20)\ D2HAT(t) = a'' + \Sigma b''E(t-j) + \Sigma d''P(t-j) + \Sigma c''D2HAT(t-j) + v''(t)$$

If a "direct effect" and an expected effect exists, then one will expect them to be in the first few lags, say first and second. The unanticipated COLA policy, D2, having a "direct effect", might suggest an expectation of the unanticipated COLA payment to take place. This is due to the negotiations and promises made by politicians, where past promises were kept or the unanticipated COLA payment effects the variables in some way that adds to the information.

As for the expected effect, if the error is large and consistently so, one can expect that this will motivate the public to pressure the authorities to increase COLA's or pay them more frequently. The reason for these COLA payment is because of an accumulated loss of real income that cannot go unnoticed and is building pressure. We can see it at the end period of this study and more so in the years following the data of this study, due to inflation rates much higher than throughout this study.

The results for the "direct effect", when E is the dependent variable significant at 10%, show that the effects of D2 acting on the intercept are significant at the second and third autoregressive order equations. For D2 block of lags at the second autoregressive order equation, we get F-test F(D2)=2.76 (.075 sig), the coefficient D2(t-2)=2.66 with T-test=2.29 (.027 sig), which implies that considering two lags the new intercept is significant (the constant coefficient is not significant). The above results suggest that the negotiations and official promises are building in a 2.66% increasing effect on exchange rate, or that we have an underlying effect on exchange rate of 2.66% primarily from the "direct effect". When the number of lags increases to 3, the coefficient D2(t-2)=2.43 (T-test=1.75 or .089 sig) with an insignificant block of lags F-test=1.28 (.298 sig). The rest of the significant results are similar to the ones in table 3 (for all significant results see appendix C).

When the slope is added too, the second lagged equation's intercept changes even farther where the coefficient D2(t-2)=8.60 (T-test=2.54 sig of .015) and the constant is -2.51 sig at 8.6% or that the underlying increasing effect on the exchange rate is large, some 6.09% (8.60-2.51). The other coefficients are very small (for all significant results see appendix D).

When P was the dependent variable, D2 acting on the intercept alone shows a significant effect on P. In the equation of order two F(D2)=3.62 (or .036 significance), the coefficient D2(t-2)=1.78 (T-test=2.29 sig at .027) together with the constant=1.92 (T-test=2.13 sig at.040), which gives a new intercept of 3.70. This implies that there is an underlying increasing effect on the CPI of 3.70%, and 1.78% is from the "direct effect". Other significant results were P(t-1)=.340 (T-test=2.37 or .022 sig), F(P)=2.82 or .071 sig and Trend=.080 (T-test=2.90 or .006 sig). When the slope was added to the model, it had neither significant effect on the slopes nor on the intercept.

The results with the expectations, D2HAT, were as follows:

Table 9
Significant VAR results for P and E dependent variables, explained by P, E, D2 and D2HAT.

		P dependent variable equations (15) with: 1 lags	2 lags	E dependent variable equations (16) with: 1 lag	2 lags	3 lags
P(t-1)	A	.317 b	.319 b	.333 c		
	B	(2.61)	(2.16)	(1.81)		
	C	.012	.037	.076		
P(t-2)	A				.382 c	.574 b
	B				(1.91)	(2.23)
	C				.064	.033
E(t-1)	A	.186 a			-.356 b	-.330 c
	B	(4.34)			(-2.38)	(-1.94)
	C	.00008			.022	.061
E(t-2)	A				-.125 c	
	B				(-1.81)	
	C				.079	
D2HAT (t-1)	A	3.02 c		5.19 b		
	B	(1.89)		(2.13)		
	C	.066		.038		
CONST	A	1.03	1.58	-1.50	-1.54	-1.42
	B	(1.09)	(1.43)	(-1.06)	(-.936)	(-.861)
	C	.280	.159	.297	.355	.395
TREND	A	.042 c	.088 a	.136 a	.157 a	.186 a
	B	(1.88)	(2.88)	(4.00)	(3.42)	(3.02)
	C	.067	.006	.0002	.002	.005
R(sq)		.4555	.4899	.4887	.4862	.5172
R(sqbr)		.3936	.3691	.4306	.3642	.3210
SEE		2.08	2.05	3.15	3.07	3.17
D.W.		1.91	1.84	2.49	1.92	2.07
F(P)		6.82 b	2.34	3.29 c	3.56 b	2.55 c
sig		.012	.110	.076	.038	.073
F(E)		18.86 a	1.10	2.28	3.42 b	1.37
sig			.343	.137	.043	.269
F(D2)		.326	.372	.124	.697	.415
sig		.571	.692	.726	.505	.743
F(D2HAT)		3.56 c	.482	4.57 b	.253	.636
sig		.066	.655	.038	.778	.597
n		50	48	50	48	46
d.f.		44	38	44	38	32

A the coefficient
B the T-test
C the significance value of the T-test
a,b,c significant at 1%, 5%, and 10% consecutively.

With expectations in the model we find the results to be significant when the dependent variable is the per cent change in CPI (equation 15) with one lag. The intercept in the first order equation is changed significantly due to expectations, where the most significant correction to the constant coefficient is at the first lag, D2HAT(t-1). The result shows that expectations will revise the effect on the constant by 3.02, from a non-significant constant to a significant one. The new constant is a large coefficient that is playing an important role explaining the underlying effect on inflation. Due to expectations, the monthly rate of inflation starts at 3.02%. In addition this equation shows that the exchange rate's role in determining the P will increase P only by an average of .186% on a 1% increase in the exchange rate. This is somewhat larger compared to the previous results with and without policy when it was .143 and .142 respectively. Most of the effect on prices comes from the prices themselves. When moving to two lags the coefficient for D2HAT is not significant, and the effect of exchange rate on P disappears.

When the exchange rate is the dependent variable (equation 16), the significant equation is the one of the first autoregressive order, where expectations show the most significant variable determining the new constant when the policy, D2=1, is implemented. Explaining the average underlying expectations on the exchange rate, the coefficient for D2HAT(t-1)=5.19 is large and significant; otherwise, it is the prices that explain the exchange rate. In the second autoregressive order equation expectations are not explaining the underlying effect of exchange rate; the explanation is only through prices and the exchange rate itself. The time trend in equation 16 is positive and at least double in size compared to equation 15.

Expectations show significance only at the first lag; this was expected because expectations are a phenomenon of inflation rates and exchange rates. Expectations are rapidly revised at high rates of inflation and devaluations. The faster prices and exchange rate change, the more rapidly the expectations will be revised to correct for the most recent error, and this is why their underlying size is large. Their effect is on prices and exchange rate.

When the expectations (equation 18), D2HAT, are the dependent variable (unanticipated COLA and noise), we get (in table 10 below) that in the order of significance the equations of 2, 3, and 4 autoregressive order have the most significant F-test. Expectations are explained by per cent change in P and by per cent change in exchange rate, where the block of lags of the per cent change in exchange rate seems to be more significant than P.

Table 10

VAR results for D2HAT dependent variable,

explained by P, and E.

		Equation with: 1 lag	2 lags	3 lags	4 lags
P(t-1)	A	-.009	-.016	.012	.010
	B	(-1.05)	(-1.31)	(.984)	(.657)
	C	.298	.196	.331	.516
P(t-2)	A		.064 a	.041 a	.037 b
	B		(5.96)	(3.43)	(2.20)
	C		0	.002	.035
P(t-3)	A			.030 b	.056 a
	B			(2.16)	(3.00)
	C			.038	.005
P(t-4)	A				.029
	B				(1.52)
	C				.138
E(t-1)	A	-.005 c	-.058 a	-.054 a	-.057 a
	B	(-1.68)	(-7.42)	(-6.89)	(-5.40)
	C	.099	0	0	0
E(t-2)	A		-.012 a	-.003	-.035 b
	B		(-3.32)	(-.278)	(-2.40)
	C		.002	.782	.022
E(t-3)	A			.008 b	-.011
	B			(2.06)	(-.745)
	C			.047	.462
E(t-4)	A				-.013 b
	B				(-2.57)
	C				.015
D2HAT (t-1)	A	.363 a	.398 a	.507 a	.206
	B	(3.42)	(4.03)	(3.62)	(1.26)
	C	.001	.0002	.0009	.219

	A		.001	-.162	-.093
D2HAT	B		(.015)	(-1.39)	(-.611)
(t-2)	C		.988	.174	.545
	A			-.210 b	-.235 c
D2HAT	B			(-2.17)	(-1.93)
(t-3)	C			.037	.063
	A				.038
D2HAT	B				(.336)
(t-4)	C				.739
	A	.302 a	.103	.047	.017
CONST	B	(4.33)	(1.26)	(.623)	(.169)
	C	0	.216	.537	.867
	A	-.002.	.003	-.003	.002
TREND	B	(-1.51)	(1.44)	(-1.02)	(.346)
	C	.139	.157	.316	.731
R(sq)		.429	.697	.820	.744
R(sqbr)		.378	.644	.769	.633
SEE		.154	.165	.150	.188
D.W.		1.76	2.37	2.02	2.14
F(P)		1.11	17.99 a	9.21 a	7.03 a
(sig)		.298		.0001	.0004
F(E)		2.83	28.06 a	22.33 a	8.31 a
(sig)		.099			.0001
F(D2HAT)		11.71	8.49 a	9.64 a	1.90
(sig)		.001	.0008	.00009	.135
n		50	48	46	44
d.f.		45	40	35	30

A the coefficient
B the T-test
C the significant value of the T-test
a significant at 1%
b significant at 5%
c significant at 10%

The coefficients for E(t-j) in all equations are small and in most cases negative. The negativity indicates that there is an inverse effect between expectations and exchange rate. The common positive values for P suggests that lagged prices raise expectations; again the coefficients are very small. As for the D2HAT in the three lagged equation, D2HAT(t-1) is significant and equal to .507, suggesting that the last period before the expectations were fulfilled (D2=1) raised the intercept to .507 or that a higher weight was placed on receiving an unexpected COLA.

Chapter 8

COMPREHENSIVE MODEL

A comprehensive model that includes all the variables was developed. A comprehensive model is the best model to estimate but, as noted before, when VAR are applied to a large model, it uses up the degrees of freedom very fast. Therefore, variables were added one at a time noticing these additional variables effect on the results. In order to determine Granger causality relations, one needed only the two original variables of the price and exchange rate. All in all we have an expanded model with four different variables E, P, D1 and D2HAT. The four variables put together into one VAR (comprehensive) model should point out the relationships between all of them. The equation showing this is equation 5, incorporating all the information.

$$(5) \quad Z(t) = \Sigma\, D(j)Z(t-J) + u(t)$$

The results obtained were divided into four groups of the four dependent variables explained by the rest so MLE is maintained (reporting only the significant results).

a. The set of equations where the exchange rate was the dependent variable yield significant results as follows:

Table 11

Significant VAR results for E dependent variable explained by lagged P, D1 and D2HAT.

		Equation with: 1 lag	2 lags	3 lags
P(t-2)	A		.498 b	.899 a
	B		(2.66)	(3.84)
P(t-3)	A			-.516 c
	B			(-1.72)
E(t-1)	A	-.206 a	-.348 b	
	B	(-3.85)	(-2.39)	
D1(t-1)	A	2.28 b	3.13 b	3.64 b
	B	(2.17)	(2.67)	(2.25)
D2HAT (t-1)	A	5.54 b		
	B	(2.43)		
D2HAT (t-2)	A		2.70 c	
	B		(1.78)	
CONST	A	-1.60	-2.30 c	-.823
	B	(-1.14)	(-1.69)	(-.540)
TREND	A	.155 a	.149 a	.176 a
	B	(4.75)	(3.53)	(3.28)
R(sq)		.548	.565	.626
R(sqbr)		.497	.462	.474
D.W.		2.17	1.72	1.86
SEE		2.96	2.82	2.80
F(P)			4.14 b	4.67 a
F(E)		14.85 a	2.86 c	
F(D1)		4.70 b	3.60 b	3.22 b
F(D2HAT)		5.91 b	3.64 b	
n		50	48	46
d.f.		44	38	32

A is the coefficient
B is the T-test
a significant at 1%
b significant at 5%
c significant at 10%

The results obtained show large coefficients that are significant. With all variables it seems as if the equation having the most significant statistics for most variables is the second order one. A shift of significance is noticed between the first order equation and the second order from the exchange rate, explaining its own behavior together with D1 and D2HAT towards those and the addition of P. In the third order equation only prices and D1 are significant. This pattern suggests, considering all lags (excluding the exchange rate variable), that the largest effect on exchange rate is taking place with two lags. The constant term is equal to an average of 3.53 (3.13+2.70-2.30) significant at 10%. The third order equation shows a very significant effect of P on the exchange rate at the second lag P(t-2) which is similar to previous findings reported in table 3, 6 and 9; again D1 is very influential on the intercept.

b. The set of equations where P was the dependent variable gave the following:

Table 12

Significant VAR results for P dependent variable explained by lagged P, E, D1 and D2HAT.

		Equations with:		
		1 lag	2 lags	3 lags
P(t-1)	A	.333 a	.455 a	.473 b
	B	(2.72)	(3.04)	(2.60)
E1(t-1)	A	.133 a		
	B	(3.69)		
D1(t-1)	A		-1.45 c	
	B		(-1.83)	
D1(t-2)	A		-1.64 b	
	B		(-2.03)	
D2HAT (t-1)	A	4.89 a		
	B	(3.17)		
D2HAT (t-2)	A		2.73 a	
	B		(2.68)	
CONST	A	.484	1.66 c	1.32
	B	(.510)	(1.80)	(1.17)
TREND	A	.057 b	.090 a	.081 b
	B	(2.58)	(3.18)	(2.05)
R(sq)		.4954	.5570	.5400
R(sqbr)		.4380	.4521	.3532
SEE		2.00	1.91	2.07
D.W.		1.90	1.86	1.90
F(P)		7.42 a	4.64 a	2.40 c
F(E)		13.60 a	1.07	.04
F(D1)		.14	2.86 c	1.40
F(D2HAT)		10.08 a	3.70 b	1.46
n		50	48	46
d.f.		44	38	32

A the coefficient
B the T-test
a significant at 1%
b significant at 5%
c significant at 10%

The set of equations where P was the dependent variable shows the most significant results in the first lag. The results are similar to what was obtained before in this paper. The exchange rate dominates in F-test significance always in the first order equation. The coefficients in the comrehensive model are playing a more significant role; some are larger and putting the underlying inflation rate at an average of 4.89 (the constant is not significant).

In the second order equation the exchange rate is not significant. The only significant coefficient at 10%, besides P, is the intercept that adds up to an average of 1.30 (-1.45-1.64+2.73+1.66) or an underlying effect on inflation of 1.3% with two lags.

A close look at the first order equation in table 11 and 12 shows that in 11 (E dependent variable), P does not explain E but in 12 (P dependent variable), E does explain P very significantly. When adding lags, the direction of influence is totally reversed in favor of P explaining E in table 11, and exchange rate not explaining P in table 12 but prices explaining themselves. This might be due to the fact that there is a time lag between an order for imports placed and the time the order reaches the country and is released from customs, paying customs at the prevailing rates, higher than the one that was at the time of order. A look at the time pattern repeats again the significance of the drift, but this time, when E is the dependent variable, it is 2 to 3 times larger than when P is the dependent variable. In addition the COLA policy and expectations are important elements at some lags, explaining the behavior of P and the exchange rate.

c. The COLA as dependent variable gives:

Table 13

Significant VAR results for D1 dependent variable explained by lagged E, P, D1 and D2HAT.

		Equations with: 1 lag	2 lags	3 lags
E(t-1)	A		.049 a	.043 b
	B		(3.10)	(2.51)
D1(t-1)	A	-.348 b	-.542 a	-.491 a
	B	(-2.47)	(-4.22)	(-2.90)
D1(t-2)	A		-.679 a	-.592 a
	B		(5.17)	(-2.92)
D2HAT (t-1)	A		-.408 b	
	B		(-2.22)	
D2HAT (t-3)	A			.514 b
	B			(2.57)
CONST	A	-.058	.244	.162
	B	(-.307)	(1.63)	(1.01)
TREND	A	.008 c	.003	.012 b
	B	(1.77)	(.694)	(2.17)
R(SQ)		.1906	.5708	.6716
R(SQBR)		.0986	.4692	.5381
SEE		.397	.309	.293
D.W.		2.41	1.96	1.89
F(P)		.002	1.11	1.09
F(E)		.527	4.84 b	2.26 c
F(D1)		6.08 b	17.15 a	13.61 a
F(D2HAT)		2.24	2.98 c	3.36 b
n		50	48	46
d.f.		44	38	32

A are coefficients
B are T-tests
a significant at 1%
b significant at 5%
c significant at 10%

An explanation regarding what effects the COLA policy, when all variables are considered, is pointed out at the second and the third autoregressive order. The exchange rate and the expectations have a strong influence on COLA policy; in addition the most important element is the regularity of the COLA payment itself. The exchange rate coefficients are similar to the ones obtained before (table 8).

d. Expectations, D2HAT, as dependent variable gives:

Table 14

Significant results for D2HAT dependent variable explained by lagged P, E, D1 and D2HAT

		Equation with: 1 lag	2 lags	3 lags
P(t-1)	A			.024 b
	B			(2.14)
P(t-2)	A		.061 a	.046 a
	B		(7.02)	(3.85)
E(t-1)	A	-.010 a	-.051 a	-.045 a
	B	(-3.84)	(-7.51)	(-6.08)
E(t-2)	A		-.011 a	
	B		(-3.49)	
E(t-3)	A			.007 c
	B			(2.02)
D1(t-1)	A	-.143 a	-.315 a	-.292 a
	B	(-2.80)	(-5.79)	(-3.93)
D1(t-2)	A		-.281 a	-.285 a
	B		(-5.03)	(-3.20)
D2HAT	A	.424 a	.301 a	.320 c
(t-1)	B	(3.82)	(3.87)	(2.02)
D2HAT	A			-.195 b
(t-3)	B			(-2.22)
CONST	A	.263 a	.137 b	.108
	B	(3.85)	(2.16)	(1.54)
TREND	A	-.001	.003	-.001
	B	(-.726)	(1.56)	(-.517)
R(sq)		.5120	.8378	.8838
R(sqbr)		.4565	.7995	.8366
SEE		.1444	.1313	.1286
D.W.		2.07	2.70	1.92
F(P)		.080	30.24 a	12.12 a
F(E)		14.75 a	28.46 a	14.97 a
F(D1)		7.82 a	22.56 a	10.14 a
F(D2HAT)		14.57 a	7.52 a	6.86 a
n		50	48	46
d.f.		44	38	32

A the coefficients
B are T-tests
a significant at 1%
b significant at 5%
c significant at 10%

The results obtained in table 14 are similar to the ones obtained in table 10. The negativity of the coefficients appears again. The coefficients are somewhat larger in some cases, but they are much more significant in most cases. The exchange rate has negative coefficients that are small, implying that the probability of the exchange rate effecting expectations is inversely related, which is not true for the prices. The COLA policy has an inverse effect on the expectations. The coefficients are large and significant, which implies that when COLA is paid (D1=1), we have a reduction in expectations, that is most significant where at one case shows to be -.315% [equation with 2 lags D1(t-1)].

A somewhat different approach is to introduce some dynamic process and let the system react to it through an impulse response.

Chapter 9

IMPULSE RESPONSE

Once VAR were estimated it is possible to develop an impulse response function. An impulse response is an inside look at the process of equations that were developed and an observation as to their dynamic behavior, the number of periods it takes to stabilize a system of equations and at which levels, when combining the decomposition of the variance and the response to one standard deviation shock in a variable. Sims [43] states clearly the relationship of the impulse response function to the Granger causal model: "A natural measure of the degree to which Granger Causal priority holds is the percentage of forecast error variable accounted for by a variable's own future disturbances in a multivariate linear autoregressive model... A variable that is optimally forecast from its own lagged values will have all its forecast error variance accounted for by its own disturbances".

One should note that the impulse response function is of little help for a policy maker, because the response

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43. Sims(1982), p.131.

recorded is under the given structure where a policy change implies a structure change and so will the results of the impulse response function. Litterman[44] says that an impulse response function is a "dynamic response of the system to an innovation in any of the components."

"This impulse response function is simply the moving average representation of the system given in (1) and (2) ...where u(t) and u'(t) are innovations in P and E process ..."

"Unit innovation may be difficult to interpret, for example, when the standard error is very small. For this reason one may wish to exploit the linearity of the system and generate a scaled version of the impulse response function which gives the response to innovations one standard error in size". About the interpretation, "first it must be recognized that one does not in general expect innovation to different variables to occur independently. The correlation matrix of the residuals will indicate which innovations are likely to occur together. Because this model is linear, the response to a combination of innovations is just the sum of their separate contributions.

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44. Litterman, p.71, 74-75.

Another caution concerns the implicit assumption that the structure of the system does not change".

In selecting the variable order for the impulse response, one should be careful. The key to the selection is stated: "Generally, among all the orderings, the one in which a particular component explains the greatest portion of the variance are those in which it is listed first". [45]

Table 15 describes a response to an innovation (one standard deviation in size) in the change of CPI of 1.97%, in the bivariate autoregressive model of order three (equation 4). The interpretation (Col.4) is that in the period of the innovation, prices grow at 1.97% on the basis of past data. The positive serial correlation of the change in CPI causes increases of .89, .156, .0058,... percent to occur in subsequent months. After 24 months the total effect is very small approaching zero (fig.4), noticing the three month cyclical behavior that is moving from positive to negative and back. The effect on E one month ahead (Col.3) is an increase of .573%. The effect two months ahead is an increase of 1.185%. These effects get smaller and smaller for the innovation in prices subsequently

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45. RATS manual, p.11-14.

approaching zero (fig.3). The same holds for the response to one standard deviation in exchange rate Col.1 and Col.2. (Plots of the responses to one standard deviation shock are following the tables, figs 1 to 4).

Table 15
RESPONSES TO ONE-STANDARD DEVIATION SHOCK

ENTRY	Col. 1	Col. 2	Col. 3	Col. 4
1	2.871	0.4930E-01	0	1.974
2	-0.9156	0.2897E-01	0.5730	0.8904
3	0.3381E-01	-0.5185E-01	1.185	0.1561
4	-0.1562	-0.6431E-01	-0.5177	0.5813E-02
5	0.6223E-01	-0.4629E-02	-0.1914	-0.2788E-01
6	-0.2781E-01	0.7057E-02	-0.1344E-01	-0.2262E-01
7	0.3451E-01	0.3759E-02	0.4680E-01	0.7389E-02
8	-0.6663E-02	0.8175E-04	0.1375E-02	0.9896E-02
9	0.6780E-03	-0.3813E-03	0.1131E-01	0.2609E-02
10	-0.3493E-02	-0.6268E-03	-0.3488E-02	-0.7803E-03
11	0.1163E-02	-0.1225E-03	-0.2027E-02	-0.6595E-03
12	-0.3352E-03	0.7063E-04	-0.1324E-02	-0.2866E-03
13	0.4115E-03	0.7502E-04	0.7054E-03	0.3719E-04
14	-0.8994E-04	0.6133E-05	0.1259E-03	0.1020E-03
15	0.3452E-04	-0.6328E-05	0.1309E-03	0.4591E-04
16	-0.5623E-04	-0.7808E-05	-0.5200E-04	-0.7136E-05
17	0.1394E-04	-0.1592E-05	-0.1501E-04	-0.1130E-04
18	-0.4252E-05	0.5394E-06	-0.2178E-04	-0.4517E-05
19	0.6074E-05	0.1051E-05	0.7286E-05	0.4491E-06
20	-0.1513E-05	0.1844E-06	0.2231E-05	0.1194E-05
21	0.6690E-06	-0.7234E-07	0.2257E-05	0.6487E-06
22	-0.7857E-06	-0.1150E-06	-0.8173E-06	-0.2702E-07
23	0.1719E-06	-0.2275E-07	-0.1643E-06	-0.1504E-06
24	-0.7525E-07	0.4748E-08	-0.3026E-06	-0.7521E-07

Col.1: Response of E.R. to 1 SD innovation in E.R.
Col.2: Response of CPI to 1 SD innovation in exchange rate
Col.3: Response of exchange rate to 1 SD innovation in CPI
Col.4: Response of CPI to 1 SD innovation in CPI
Correlation if innovations in CPI and E.R. is .024963

Table 16
COVARIANCE MATRIX

VARIABLE	CPI	E.R.
CPI	3.9000	0.14156
E.R.	0.14156	8.2454

CORRELATION MATRIX

CPI	1.0000	0.024963
E.R.	0.024963	1.0000

FIGURE 1

Response of E.R. to 1 SD innovation in E.R.(Col.1)

```
    ++++++++++++++++++++++++++++++++++++++++++++++++++
 1  +           +                                    A
 2  A           +                                    +
 3  +           A                                    +
 4  +         A +                                    +
 5  +           +A                                   +
 6  +          A+                                    +
 7  +           A                                    +
 8  +           A                                    +
 9  +           A                                    +
10  +           A                                    +
11  +           A                                    +
12  +           A                                    +
13  +           A                                    +
14  +           A                                    +
15  +           A                                    +
16  +           A                                    +
17  +           A                                    +
18  +           A                                    +
19  +           A                                    +
20  +           A                                    +
21  +           A                                    +
22  +           A                                    +
23  +           A                                    +
24  +           A                                    +
    ++++++++++++++++++++++++++++++++++++++++++++++++++
    MIN VALUE -0.9156 MAX VALUE 2.8715 SPACING 0.0773
```

Figure 2

Response of CPI to 1 SD innovation in E.R. (Col.2)

```
    ++++++++++++++++++++++++++++++++++++++++++++++++++
  1 +                           +                    A
  2 +                           +           A        +
  3 +    A                      +                    +
  4 A                           +                    +
  5 +                         A +                    +
  6 +                           +  A                 +
  7 +                           +A                   +
  8 +                           A                    +
  9 +                           A                    +
 10 +                          A+                    +
 11 +                           A                    +
 12 +                           A                    +
 13 +                           A                    +
 14 +                           A                    +
 15 +                           A                    +
 16 +                           A                    +
 17 +                           A                    +
 18 +                           A                    +
 19 +                           A                    +
 20 +                           A                    +
 21 +                           A                    +
 22 +                           A                    +
 23 +                           A                    +
 24 +                           A                    +
    ++++++++++++++++++++++++++++++++++++++++++++++++++
    MIN VALUE -0.0643 MAX VALUE 0.0493 SPACING 0.0023
```

Figure 3

Response of E.R. to 1 SD innovation in CPI (Col.3)

```
    ++++++++++++++++++++++++++++++++++++++++++++++++++
 1  +              A                                 +
 2  +              +               A                 +
 3  +              +                                 A
 4  A              +                                 +
 5  +        A     +                                 +
 6  +              A                                 +
 7  +              +A                                +
 8  +              A                                 +
 9  +              A                                 +
10  +              A                                 +
11  +              A                                 +
12  +              A                                 +
13  +              A                                 +
14  +              A                                 +
15  +              A                                 +
16  +              A                                 +
17  +              A                                 +
18  +              A                                 +
19  +              A                                 +
20  +              A                                 +
21  +              A                                 +
22  +              A                                 +
23  +              A                                 +
24  +              A                                 +
    ++++++++++++++++++++++++++++++++++++++++++++++++++
```

MIN VALUE -0.5177 MAX VALUE 1.1850 SPACING 0.0347

Figure 4

Response of CPI to 1 SD innovation in CPI (Col.4)

```
    ++++++++++++++++++++++++++++++++++++++++++++++++++
 1  ++                                               A
 2  ++                    A                          +
 3  ++   A                                           +
 4  +A                                               +
 5  A+                                               +
 6  A+                                               +
 7  +A                                               +
 8  +A                                               +
 9  +A                                               +
10  +A                                               +
11  +A                                               +
12  +A                                               +
13  +A                                               +
14  +A                                               +
15  +A                                               +
16  +A                                               +
17  +A                                               +
18  +A                                               +
19  +A                                               +
20  +A                                               +
21  +A                                               +
22  +A                                               +
23  +A                                               +
24  +A                                               +
    ++++++++++++++++++++++++++++++++++++++++++++++++++
    MIN VALUE -0.0279 MAX VALUE 1.9740 SPACING 0.0409
```

Figure 5

Response to 1 SD innovation (Col.1 to Col.4)

```
    ++++++++++++++++++++++++++++++++++++++++++++++++++
 1  +           &                        D           A BC
 2  A           B      C   D                         +
 3  +          BA D            C                     +
 4  +    C    ABD                                    +
 5  +        C DBA                                   +
 6  +          A&                                    + BCD
 7  +           &                                    + ABCD
 8  +           &                                    + ABCD
 9  +           &                                    + ABCD
10  +           &                                    + ABCD
11  +           &                                    + ABCD
12  +           &                                    + ABCD
13  +           &                                    + ABCD
14  +           &                                    + ABCD
15  +           &                                    + ABCD
16  +           &                                    + ABCD
17  +           &                                    + ABCD
18  +           &                                    + ABCD
19  +           &                                    + ABCD
20  +           &                                    + ABCD
21  +           &                                    + ABCD
22  +           &                                    + ABCD
23  +           &                                    + ABCD
24  +           &                                    + ABCD
    ++++++++++++++++++++++++++++++++++++++++++++++++++
    MIN VALUE -0.9156 MAX VALUE 2.8715 SPACING 0.0773
```

Table 17 on the following page shows the decomposition of the variance, of the exchange rate standard error and CPI standard error, into parts due to the variance in the "orthogonalized innovation" [46] 24 steps (months) ahead in the 3 lagged equation. This forecast error of the exchange rate and prices is due to the innovation in exchange rate and prices. The table reveals that after 24 months more than 18% in the variance in exchange rate is generated from innovatons in prices (18.29%) and the rest of the variance (81.71%) is from innovations in the exchange rate themselves. The decomposition of variance in the prices show that less than 1% in the variance of prices is generated from the exchange rate and the rest (99.78%) is due to the prices themselves. This "innovation accounting" can be of some verification that exchange rate is caused by inflation (Granger-caused), noticing the small effect of the exchange rate on the variance of the prices.

---

46. Rates manual, p.11-12.

Table 17

DECOMPOSITION OF VARIANCE

	STAN ERR k-steps ahead	% caused by shock in E.R.	% caused by shock in CPI
In exchange rate			
k= 1	2.87149	100.000000	0.000000
k= 2	3.06792	96.511299	3.488701
k= 3	3.28898	83.984257	16.015743
k= 4	3.33314	81.993316	18.006684
k= 5	3.33921	81.730193	18.269807
k= 6	3.33947	81.724215	18.275785
k= 7	3.33998	81.710118	18.289882
k= 8	3.33999	81.710176	18.289824
k= 9	3.34000	81.709240	18.290760
k=10	3.34001	81.709171	18.290829
k=11	3.34001	81.709143	18.290857
k=24	3.34001	81.709127	18.290873
In CPI			
k= 1	1.97485	0.062314	99.937686
k= 2	2.16649	0.069653	99.930347
k= 3	2.17273	0.126199	99.873801
k= 4	2.17369	0.213608	99.786392
k= 5	2.17387	0.214025	99.785975
k= 6	2.17400	0.215053	99.784947
k= 7	2.17401	0.215349	99.784651
k= 8	2.17404	0.215345	99.784655
k= 9	2.17404	0.215347	99.784653
k=10	2.17404	0.215356	99.784644
k=24	2.17404	0.215356	99.784644

When the information of the policy, D1, and expectations, D2HAT, were incorporated into the impulse response function, of the autoregressive model of order three, we find that at the end of 24 months, a one standard deviation (SD) shock in P caused an after shock effect on P to be larger than when these variables were not part of the model. The response to the shock is decreasing to a small number but not as small as before. The response to 1 SD shock in P on the exchange rate did not nullify as fast as the case was without additional variables (table 18). In addition one notices that the shock through the 24 steps in many cases follows a pattern, like 3 negative values followed by 3 positive values, etc.. Other patterns are noticed, too in app E.1,F.1 and G.2.

Table 18

Selective responses to 1 SD shock for the models:

	A	B	C	D
Model variables: E.R., P, D1				
k= 1	2.405	.141	0	1.83
k= 2	-.568	.277	-.023	.835
K= 3	.393	-.075	1.40	.165
K= 4	-.546	-.327	-.504	.082
K= 5	-.491	.001	.026	-.070
K=10	-.076	-.067	-.112	.003
K=24	.0078	.001	(-)0	-.001
Model variables: E.R., P, D2HAT				
k= 1	2.703	-.124	0	1.81
k= 2	-.959	-.049	.233	.744
k= 3	-.119	-.109	1.17	.127
k= 4	-.161	-.382	-.506	.119
k= 5	-.221	-.091	.236	.267
k=10	-.112	-.093	-.089	-.040
k=24	.009	.009	.010	.008
Model variables: E.R., P, D1 and D2HAT				
k= 1	2.33	.004	0	1.72
k= 2	-.566	.059	.003	.777
k= 3	.162	-.174	1.20	.120
k= 4	-.629	-.368	-.339	.171
k= 5	-.149	-.041	.251	.203
k=10	-.185	-.152	-.216	.001
k=24	.008	.007	.021	.007

A is response to 1 SD shock in exchange rate on exchange rate
B is response to 1 SD shock in exchange rate on P
C is response to 1 SD shock in P on E.R.
D is the response to 1 SD shock in P on P

The decomposition of variance at the first 5 steps seems most dynamic. The steps following the first five change very little (as seen in appendix where all steps from 1 to 24 are listed).

Table 19

Decomposition of variance in P (1 SD ahead)

step=k		E.R.	P	D1	D2HAT
k= 1					
	A	.06	99.94		
	B	.59	99.41	0	
	C	.47	99.53		0
	D	0	99.99	0	0
k= 2					
	A	.07	99.93		
	B	2.24	94.13	3.63	
	C	.46	99.29		.24
	D	.09	98.74	.73	.43
k= 3					
	A	.13	99.87		
	B	2.22	88.86	8.92	
	C	.74	94.95		4.31
	D	.89	93.91	2.15	3.05
k= 5					
	A	.21	99.79		
	B	4.44	86.84	8.72	
	C	4.24	90.77		4.99
	D	4.14	88.68	3.45	3.71

A is the model with E.R. and P variables
B is the model with E.R., P and D1 variables
C is the model with E.R., P and D2HAT variables
D is the model with all: E.R., P, D1 and D2HAT variables.

The decomposition of variance in P reveals that in all cases, at the first step ahead, more than 99% of the variance in P is generated from innovations in P. At the second step ahead when COLA, D1, is incorporated, the policy generates only 3.63% of the variance in P and the exchange rate generates only 2.24% of the variance in P. At the third step ahead, the policy effect is growing to almost 9% (line B) and the expectations generate more than 4% of the variance (line C) and more than 3% (line D). When following the decomposition of the variance a step at a time, one can see how each variable takes its steady position of explaining the variance in P, where, as early as the fifth step, the positions are almost final. The exchange rate explains the variance in P at more than 4% (excluding line A), COLA policy more than 8% (line B), and expectations almost reaching 5% (line C). The results at the 24th step are not too much different: D1 is reaching to more than 7% (D) and expectations are 6% (C), (Appendix G.3.2 and F.3.2 respectively). In no case do all other variables determine more than 17.15% of variance (App G.3.2).

Table 20

Decomposition of variance in exchange rate (1 SD ahead)

		E.R.	P	D1	D2HAT
k= 2					
	A	96.51	3.48		
	B	92.47	.011	7.52	
	C	96.26	.63		3.10
	D	88.47	0	10.52	1.30
k= 3					
	A	83.98	16.01		
	B	63.36	19.87	16.77	
	C	82.90	14.39		2.71
	D	64.58	16.12	18.23	1.06
k= 5					
	A	81.73	18.27		
	B	59.14	19.30	21.56	
	C	79.56	16.66		3.77
	D	62.22	16.27	20.11	1.39

For A, B, C and D, see table 19.

The decomposition of variance in the exchange rate reveals that in the second step ahead (first step has 100 or 0 values only), almost 3.5% of the variance in exchange rate is generated from P (line A) but this portion that the P variable has on exchange rate is declining when more variables are added. The D1 policy picks up more than 7.5% and 10.5% in line C, B and line D. The expectation picks up more than 3% and 1% in line C and line D from the variance. The third step ahead shows a very large increase of variance, attributed to other than the exchange rate variable. Additional steps again show that the fifth step is very similar to the final result in the 24th step ahead or that at the 24th step at least 16% in the variance in exchange rate is generated from innovations in P and more than 20% is generated from innovations in D1.

When other variables are part of the model, we find that they play an important role in the decomposition of the variance of the exchange rate up to more than 43% at the D model (app G.3.1), where P alone determines more than 19% at the 24th step of the B model (app E.3.1).

One can conclude from this "innovation accounting" that the exchange rate is more vulnerable to be effected by the other variables than the P variable.

Chapter 10

PURCHASING POWER PARITY

The period the paper concentrates on is the period when the exchange rate was allowed to change with government control, which is a controlled float or a dirty float, nevertheless less control than at the previous period. At a time of high inflation rates one will expect to find that if the exchange rate in the short run can be tampered with, it will be adjusted to maintain the competitiveness of the Israeli goods in international markets, or that the terms of trade will be maintained. One theorem that might show this, although not a perfect one, will be the Purchasing-Power-Parity Theorem (PPP), an important part in exchange rate determination.

> "The PPP essentially asserts that prices in one country must equal those in another country when expressed in common currency. Depending on the model at hand, the PPP theorem can be stated as an arbitrage condition or as a proposition pertaining only to tradeable goods. There are two versions: In one, it is absolute prices that are equalized, whereas in the other, it is only proportionate rates of price level change that are reflected in proportional movements in exchange rates. PPP can hold because exchange rates determine prices, or conversely. PPP can be assumed to hold through arbitrage, or it can be a theory of exchange rate or price level determination."[47]

The absolute PPP theory is stating that the equilibrium exchange rate (E.R.) should be equal to the ratio of price levels (P) in two nations or:

(21) E.R.(IL/$)=ISCPI/USCPI

where: ISCPI is CPI in Israel and
USCPI is CPI in U.S.

The second approach, proportionate or relative PPP theory states: "The change in the exchange rate over a period of time should be proportional to the relative change in the price levels in the two nations over the same time period".[48]

The relative PPP theory (the one that will be used) is described by:

(22) PPP = P/EE [49]

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47. A.O. Krueger, "Exchange Rate Determination", Cambridge Surveys of Economic Literature, Cambridge University Press, 1983, p.24.

48. D.Salvatore, International Economics, Macmillan Pub Co. 1983, p.381.

49. Salvatore, p.381.

where: $P = P(1)/P(2)$ where:

$P(1) = ISCPI(t)/ISCPI(t-1)$

$P(2) = USCPI(t)/USCPI(t-1)$

$EE = EERIS(t)/EERIS(t-1)$

EERIS is the Effective Exchange Rate, Israel(IL/$)

t is time

The following possibilities are available:

1. P = EE, an indication that PPP = 1; there is full adjustment between prices and exchange rate.

2. P>EE will indicate that prices did increase faster than exchange rate and, therefore, the exchange rate is appreciated (PPP >1).

3. P < EE will indicate that exchange rate is depreciated (PPP<1).

A close look at the Israeli economy shows the relative PPP to be:

Table 21

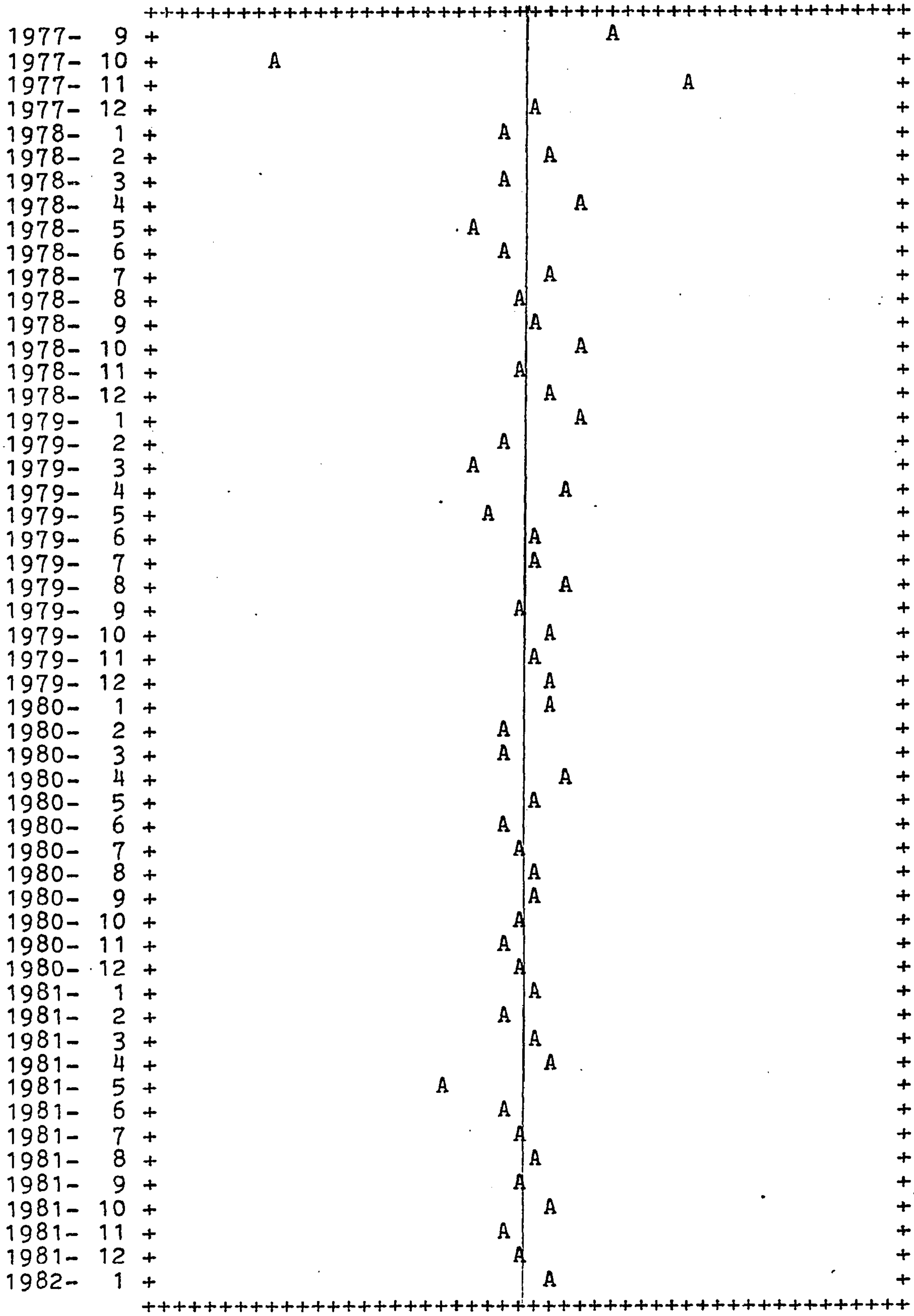
Relative Purchasing Power Parity results

from equation 22

Year	PPP	YEAR	PPP
1977- 9	1.110	1980- 1	1.027
1977- 10	0.6710	1980- 2	0.9672
1977- 11	1.207	1980- 3	0.9738
1977- 12	1.010	1980- 4	1.059
1978- 1	0.9789	1980- 5	1.000
1978- 2	1.031	1980- 6	0.9599
1978- 3	0.9644	1980- 7	0.9894
1978- 4	1.062	1980- 8	1.007
1978- 5	0.9383	1980- 9	1.019
1978- 6	0.9775	1980-10	0.9857
1978- 7	1.037	1980-11	0.9766
1978- 8	0.9901	1980-12	0.9800
1978- 9	1.007	1981- 1	1.020
1978- 10	1.062	1981- 2	0.9751
1978- 11	0.9913	1981- 3	1.003
1978- 12	1.027	1981- 4	1.023
1979- 1	1.065	1981- 5	0.8907
1979- 2	0.9753	1981- 6	0.9643
1979- 3	0.9231	1981- 7	0.9955
1979- 4	1.054	1981- 8	1.010
1979- 5	0.9538	1981- 9	0.9968
1979- 6	1.008	1981-10	1.024
1979- 7	1.014	1981-11	0.9783
1979- 8	1.045	1981-12	0.9930
1979- 9	0.9947	1982- 1	1.026
1979- 10	1.027		
1979- 11	1.005		
1979- 12	1.023		

PPP follows equation 22 above.

Fig 6
plot of the PPP
(min value of 0.5, max value of 1.5, spacing of 0.020408.)



Some readings in table 21 show that PPP were equal to as high as 1.207 in November 1977, which was the month following the adoption of the new floating exchange rate system. The lowest reading of PPP was .891 in May 1981 (a month before the elections of June 30, 1981), not counting October 1977, the month of the large devaluation and the move to the floating exchange rate system. An average of the PPP (table 21), when including October 1977 (without September 1977), is .9978 with a standard deviation of .064665, when excluding October 1977, and starting at November 1977 the average is 1.00423 with a standard deviation of .04568.

The results show that for about half of the time PPP is larger than 1, the adjustment in the exchange rate did not follow fast enough to maintain the terms of trade. If the target is to be on the average close to PPP=1, then the target is achieved. Otherwise, the target is not achieved. For about half of the period studied, the prices increased faster than the exchange rate. Since inflation Granger-causes devaluation, there is a time lag (a month or two) that the exchange rate is behind its par value. During the time PPP is lagging (larger than 1), it implies that imported goods are arriving at the market at lower prices than if the change in the exchange rate was equal to the change in P (equation 22). There will be excess supply of domestic currency and a devaluation should follow, unless the Central Bank steps in and supplies foreign currency at a fixed and known price, keeping the domestic currency at its artificial value.

To conclude this, Caves and Jones say, "Indeed, the theoretical models of fixed and flexible exchange rates together suggest that when the exchange rate and price level are inconsistent with each other, the country can make policy choice of whether it adjusts the exchange rate to the price level or the price level to the exchange rate". [49]

In our case, it was shown that price change had an effect on devaluation and not inversely. It seems that the way to reduce the lag of the adjustment had to be by the policymaker, by taking control of the price level and reducing the inflation that in turn will slow down the devaluation. A trial to control the exchange rate instead is worthless.

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49. R.E.Caves and R.W.Jones, World Trade and Payment, 3rd ed., Little, Brown and Comp, 1981, p.373.

Chapter 11

Conclusion

The inflation exchange rate causality ordering is a very important one, in order for a policy maker to decide what policies to adopt for pursuing an objective specified. The objective for the Israeli economy for the period this paper investigates was to achieve growth by establishing a sound economic structure. In a small country that depends on its international reserves holdings, a policy regarding inflation and exchange rate are of utmost importance because of their effect on the growth. Determination of causality relationships is the first step to be taken in order to follow up with the "right" policies.

This paper shows that in the case of Israel inflation has its effect on the exchange rate-devaluation and not the other way around for the period tested. This is a very important result when realizing that the Bank of Israel took the opposite approach in order to encourage growth. A mistake in the diagnosis has its impact beyond the present following into the near future and sometimes beyond, all depending on how long the wrong policies were pursued and the degree of structural damage that was done due to the mistake.

This paper shows that the COLA policy has an impact on the underlying devaluation in Israel through higher wages and again verifies that inflation is explaining the devaluation or causing it, together with the COLA policy.

The expectations are another element explaining the underlying devaluation rate but in addition it shows an impact on the prices as well in both in the first and second lag.

A comprehensive model that includes all the variables repeats the same results.

An impulse response function showed that it takes about seven periods to stabilize the system with the price and exchange rate model. It takes a lot longer when the policy-D1 is part of the model. The decomposition of variance repeats again that the standard error in exchange rate is influenced strongly by the price where the opposite is not true in the price exchange rate model. In the model that includes the policy, D1, the policy takes a major part in the decomposition of variance in exchange rate in all cases together with the prices.

The discussion of the relative PPP (for the effective exchange rate) shows that the PPP was not significantly different than 1 on the average for the period of the study.

VAR models are limited in their ability to determine policy as stated by Sargent (see above). This will imply that we are quite limited on what can be suggested for future behavior.

If one is pressured to write future recommendations anyway, then it might be pointed out that expectations are an important element in the public's eye in adjusting their behavior. In hyperinflation in Israel the demand pull inflation dominates behavior. Therefore, policies should be directed to those elements in such a way that the economic structure will change in order to increase growth. A policy towards controlling inflation and expectations alone is not enough.

APPENDIXES

DATA

It seems that some lengthy explanation of the data collection is required. In order to get the Effective Exchange Rate (the formal rate + taxes on imports that are custom duty, surcharges, purchase tax and funds [1]) per month, the import taxes data had to be acquired. While looking for this data at different locations in the U.S., it was clear that monthly data will not be available in the U.S.. In December 1982 a trip to Israel was taken and the hunt for the data started. The monthly data was not found in ordinary publications of the Central Bureau of Statistics. A trip to the Bureau in Jerusalem revealed that monthlv data is not submitted to the Bureau due to lack of interest in the past. It was recommended to approach the department of income receipts in the Ministry of Finance, which was where the data was found. In response to the question of why this data is not available in any other

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1. "Net Funds" are charges (less subsidies) connected with imports. The funds are of two kinds: a. where the government imports goods and resells them on the domestic market, the difference between the cost of purchase abroad and the sales price on the domestic market being in the form of a charge (positive difference) or subsidy (negative difference); b. where the government imposes an additional tax (or grants a subsidy) on imported goods (such as the Agricultural Equilizing Fund).

place, the answer was that out of the department no one asked for it on a monthly basis, only quarterly or yearly.

The rest of the data was collected from Foreign Trade Statistics Monthly, Statistical Abstract of Israel and International Financial Statistics.

The Effective Exchange Rate is "the price actually paid and received by traders for foreign exchange." [2] The effective rate of exchange for imports is the formal rate and the addition of the "Average Payment in Israeli Currency per U.S. Dollar of Imported Goods." [3] The import tax payments are custom duty, surcharges, purchase tax and funds. The "average payment" of imported goods, seasonally adjusted, was found and added to the formal rate to get effective rate of exchange for imports all in monthly data from August 1977 to January 1982.

The data for the CPI is monthly as noted. In Israel the CPI is for the full length of the month, or from month end to month end. The exchange rate data is available for end of month or average of month. In this paper the end of month exchange rate data will be used unless otherwise noted. The end of month sets of data are used in both

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2. Anne O. Krueger, Exchange Rate Determination, Cambridge Surveys of Economic Literature, Cambridge University Press, 1983, p.17.

3. Statistical Abstract of Israel, 1982, No.33, p.34.

variables.

The next pages list the data and in some cases will explain how it was obtained.

App A.1
IMPORT TAX DATA

	1 IMTAS	2 IMCTS	3 IMIMS	4 IMIMSS
1977- 9	442467.	263007.	0	26669.0
1977- 10	605799.	370009.	0	25075.0
1977- 11	358641.	334427.	0	1918.0
1977- 12	326209.	382320.	0	9909.0
1978- 1	301390.	428103.	0	612.0
1978- 2	231259.	303462.	0	178.0
1978- 3	668359.	253798.	0	-5480.0
1978- 4	335934.	398105.	12520.	430.0
1978- 5	389192.	541408.	31956.	407.0
1978- 6	433787.	531839.	1438.	133.0
1978- 7	392256.	537575.	13686.	573.0
1978- 8	473710.	481217.	10938.	55.0
1978- 9	482356.	619975.	8618.	-637.0
1978- 10	386109.	597575.	-12169.	43.0
1978- 11	534445.	860233.	6347.	-16.0
1978- 12	642855.	806424.	4841.	0.
1979- 1	647293.	947710.	7204.	107.0
1979- 2	667556.	959287.	1857.	0
1979- 3	769970.	1134720.	4155.	578.0
1979- 4	753715.	1038850.	2331.	97.0
1979- 5	1002670.	1312910.	1510.	57.0
1979- 6	787197.	1120760.	230.	0
1979- 7	918644.	1183320.	1482.	0
1979- 8	879154.	1135110.	1744.	14.0
1979- 9	984494.	1264170.	50.	0
1979- 10	906725.	1340770.	1257.	0
1979- 11	993615.	1418650.	1017.	0
1979- 12	823971.	987620.	-2185.	0
1980- 1	838918.	936365.	1406.	0
1980- 2	785220.	969977.	1280.	-12.0
1980- 3	868175.	1147610.	1024.	0
1980- 4	917350.	1098050.	0	0
1980- 5	1017040.	1288560.	0	0
1980- 6	1115390.	1415330.	0	0
1980- 7	1436860.	1600560.	0	0
1980- 8	1350340.	1723870.	0	0
1980- 9	1343910.	1449420.	0	0
1980- 10	1812130.	2431500.	0	0
1980- 11	2116080.	3061980.	0	0
1980- 12	2235160.	3409610.	0	0
1981- 1	2009610.	2643050.	0	0
1981- 2	2030550.	3132780.	0	0

1981- 3	3257010.	4716150.	0	0
1981- 4	2731930.	4595110.	0	0
1981- 5	3385560.	4816560.	0	0
1981- 6	3223950.	3916950.	0	0
1981- 7	3692620.	4655380.	0	0
1981- 8	3311820.	3576320.	0	0
1981- 9	3380280.	4593670.	0	0
1981- 10	4078570.	5672250.	0	0
1981- 11	5760410.	7451820.	0	0
1981- 12	5906640.	8439270.	0	0
1982- 1	5620930.	8184750.	0	0

Source: Ministry of Finance, Income Receipts Department.

IMTAS is IMport Tax in Shekels

IMCTS is IMport Consumer Tax in Shekels

IMIMS is IMport IMport Tax in Shekels

IMIMSS is IMport IMport Service Tax in Shekels.

App A.2
Data

	IMTTS	IMSA	FEREND	FERA
1977- 9	732143.	376.500	10.30	10.30
1977- 10	1000880.	278.600	15.25	15.25
1977- 11	694986.	332.400	15.30	15.24
1977- 12	718438.	342.000	15.39	15.32
1978- 1	730105.	342.000	16.03	15.77
1978- 2	534899.	354.500	16.27	16.05
1978- 3	916677.	357.000	16.42	16.43
1978- 4	746989.	381.100	16.73	16.53
1978- 5	962963.	363.200	17.45	16.98
1978- 6	967197.	332.000	17.83	17.52
1978- 7	944090.	434.800	18.17	17.93
1978- 8	965920.	379.700	18.37	18.23
1978- 9	1110310.	384.400	18.35	18.36
1978- 10	971558.	392.200	18.51	18.35
1978- 11	1401010.	398.500	18.85	18.77
1978- 12	1454120.	427.900	19.02	18.74
1979- 1	1602310.	573.300	19.11	18.98
1979- 2	1628700.	465.600	19.24	19.46
1979- 3	1909420.	438.300	21.42	20.05
1979- 4	1795000.	493.500	22.64	22.02
1979- 5	2317150.	531.000	24.15	23.65
1979- 6	1908190.	516.800	25.25	24.67
1979- 7	2103450.	535.900	25.87	25.60
1979- 8	2016030.	585.100	27.13	26.60
1979- 9	2248720.	575.000	28.95	28.20
1979- 10	2248750.	625.100	30.59	29.86
1979- 11	2413280.	584.400	32.84	31.81
1979- 12	1809410.	548.800	35.35	34.05
1980- 1	1776690.	650.600	37.06	36.35
1980- 2	1756470.	579.500	39.55	38.42
1980- 3	2016810.	529.400	41.48	40.42
1980- 4	2015400.	550.200	43.00	42.76
1980- 5	2305600.	502.200	45.98	44.82
1980- 6	2530720.	524.600	49.68	47.80
1980- 7	3037420.	598.000	52.38	51.03
1980- 8	3074210.	550.400	55.78	54.08
1980- 9	2793330.	564.200	59.05	57.41
1980- 10	4243630.	562.100	63.70	61.12
1980- 11	5178060.	539.500	69.70	66.89
1980- 12	5644770.	592.400	75.48	73.95
1981- 1	4652660.	577.900	80.64	78.95
1981- 2	5163330.	613.400	86.55	83.94

1981- 3	7973160.	628.600	88.70	88.18
1981- 4	7327040.	661.900	94.89	92.54
1981- 5	8202120.	589.700	107.98	101.83
1981- 6	7140900.	593.900	116.76	113.88
1981- 7	8348000.	589.000	121.50	120.47
1981- 8	6888140.	602.200	127.07	124.79
1981- 9	7973950.	557.200	134.40	130.94
1981- 10	9750820.	608.900	142.10	137.40
1981- 11	13212200.	632.000	149.60	145.07
1981- 12	14345900.	597.600	156.04	153.05
1982- 1	13805700.	626.100	167.44	161.68

Source: Ministry of Finance, Income Receipt Department

IMTTS is IMport Tax Total in Shekels (1+2+3+4 from APP A.1)

IMSA is IMports Seasonally Adjusted in Dollars

FERA is the Formal Exchange Rate Average of the month.

FEREND is the Formal Exchange Rate END of the month.

Plot of the formal E.R.(A), the tax per dollar import(B) and the effective E.R.(C). (Min value is 1.5089, max value 189.49, spacing of 3.8364).

```
         ++++++++++++++++++++++++++++++++++++++++++++++++++
1977-  9 B AC                                             +
1977- 10 +B  AC                                           +
1977- 11 B   &                                            + AC
1977- 12 B   &                                            + AC
1978-  1 B   &                                            + AC
1978-  2 B   &                                            + AC
1978-  3 B   AC                                           +
1978-  4 B   &                                            + AC
1978-  5 B   AC                                           +
1978-  6 B   AC                                           +
1978-  7 B   AC                                           +
1978-  8 B   AC                                           +
1978-  9 B   AC                                           +
1978- 10 B   AC                                           +
1978- 11 +B   &                                           + AC
1978- 12 B    &                                           + AC
1979-  1 B    &                                           + AC
1979-  2 +B   AC                                          +
1979-  3 +B   AC                                          +
1979-  4 +B    &                                          + AC
1979-  5 +B    AC                                         +
1979-  6 +B    AC                                         +
1979-  7 +B    AC                                         +
1979-  8 +B     AC                                        +
1979-  9 +B     AC                                        +
1979- 10 +B      AC                                       +
1979- 11 +B      AC                                       +
1979- 12 B        AC                                      +
1980-  1 B        AC                                      +
1980-  2 B         AC                                     +
1980-  3 +B        AC                                     +
1980-  4 +B         AC                                    +
1980-  5 +B          AC                                   +
1980-  6 +B           AC                                  +
1980-  7 +B           A C                                 +
1980-  8 +B            A C                                +
1980-  9 +B             AC                                +
1980- 10 + B             A C                              +
1980- 11 + B               A C                            +
1980- 12 + B                A  C                          +
1981-  1 + B                  A C                         +
1981-  2 + B                   A C                        +
1981-  3 +  B                   A  C                      +
1981-  4 + B                     A  C                     +
1981-  5 +  B                        A  C                 +
1981-  6 +  B                          A  C               +
1981-  7 +  B                           A   C             +
1981-  8 +  B                             A  C            +
1981-  9 +  B                               A  C          +
1981- 10 +   B                                A   C       +
1981- 11 +    B                                 A    C    +
1981- 12 +     B                                 A      C +
1982-  1 +    B                                     A     C
         ++++++++++++++++++++++++++++++++++++++++++++++++++
```

Plot (App A.3) of the percent change of: the formal E.R.(A),
tax per dollar imports(B) and the effective E.R.(C).
(Min value -41.801, max value 84.744, spacing 2.5826.)

```
         +++++++++++++++++++++++++++++++++++++++++++++++++++
1977-  9 + B           C +A                                +
1977- 10 +               +                   A C           B
1977- 11 B            C  A                                 +
1977- 12 +               &                                 + ABC
1978-  1 +               +B&                               + AC
1978-  2 +    B         C+A                                +
1978-  3 +               +A C                        B     +
1978-  4 +      B        CA                                +
1978-  5 +               + AC           B                  +
1978-  6 +               +&   B                            + AC
1978-  7 +     B        C+A                                +
1978-  8 +               +&      B                         + AC
1978-  9 +               AC   B                            +
1978- 10 +          B    CA                                +
1978- 11 +               +A C             B                +
1978- 12 +              BCA                                +
1979-  1 +        B     CA                                 +
1979-  2 +               A C        B                      +
1979-  3 +               +    &     B                      + AC
1979-  4 +         B     +CA                               +
1979-  5 +               +  &     B                        + AC
1979-  6 +         B     +CA                               +
1979-  7 +               +& B                              + AC
1979-  8 +          B    +CA                               +
1979-  9 +               +  & B                            + AC
1979- 10 +            B  + &                               + AC
1979- 11 +               +  &   B                          + AC
1979- 12 +       B       + CA                              +
1980-  1 +         B     +CA                               +
1980-  2 +               +  &B                             + AC
1980-  3 +               + AC       B                      +
1980-  4 +              B+CA                               +
1980-  5 +               +  &       B                      + AC
1980-  6 +               + B&                              + AC
1980-  7 +               + &                               + ABC
1980-  8 +               +  &B                             + AC
1980-  9 +           B   + &                               + AC
1980- 10 +               +  A C                B           +
1980- 11 +               +   AC      B                     +
1980- 12 +               B  &                              + AC
1981-  1 +         B     + CA                              +
1981-  2 +               + B&                              + AC
1981-  3 +               +A C                 B            +
1981-  4 +          B    + CA                              +
1981-  5 +               +      &   B                      + AC
1981-  6 +          B    + CA                              +
1981-  7 +               + &     B                         + AC
1981-  8 +        B      +CA                               +
1981-  9 +               + AC       B                      +
1981- 10 +               + AC B                            +
1981- 11 +               + AC         B                    +
1981- 12 +               + &    B                          + AC
1982-  1 +            B  + CA                              +
         +++++++++++++++++++++++++++++++++++++++++++++++++++
```

App A.3

Per cent change, CPI and E.R. data

and the plot of the % change.

	ISCPI	PCISCPI	EEREND	PCEEREND
1977- 9	141.000	3.82916	12.2446	-6.82353
1977- 10	146.100	3.61702	18.8425	53.8842
1977- 11	163.400	11.8412	17.3908	-7.70439
1977- 12	166.600	1.95838	17.4907	0.57444
1978- 1	170.400	2.28091	18.1648	3.85405
1978- 2	173.100	1.58451	17.7789	-2.12444
1978- 3	179.500	3.69728	18.9877	6.79907
1978- 4	189.400	5.51532	18.6901	-1.56733
1978- 5	192.900	1.84794	20.1013	7.55052
1978- 6	196.700	1.96993	20.7432	3.19333
1978- 7	201.400	2.38943	20.3413	-1.93750
1978- 8	206.200	2.38332	20.9139	2.81496
1978- 9	212.400	3.00679	21.2384	1.55160
1978- 10	224.600	5.74388	20.9872	-1.18276
1978- 11	238.600	6.23330	22.3657	6.56829
1978- 12	246.800	3.43671	22.4183	0.23518
1979- 1	259.000	4.94327	21.9049	-2.29009
1979- 2	265.300	2.43243	22.7381	3.80372
1979- 3	280.200	5.61628	25.7764	13.3622
1979- 4	304.500	8.67238	26.2773	1.94325
1979- 5	319.000	4.76190	28.5137	8.51077
1979- 6	330.300	3.54232	28.9423	1.50314
1979- 7	348.500	5.51014	29.7951	2.94655
1979- 8	377.700	8.37877	30.5756	2.61956
1979- 9	407.900	7.99576	32.8608	7.47393
1979- 10	439.800	7.82054	34.1874	4.03703
1979- 11	482.600	9.73170	36.9695	8.13779
1979- 12	521.700	8.10195	38.6470	4.53752
1980- 1	559.900	7.32222	39.7908	2.95961
1980- 2	587.500	4.92945	42.5810	7.01217
1980- 3	617.200	5.05532	45.2896	6.36105
1980- 4	680.500	10.2560	46.6630	3.03248
1980- 5	744.900	9.46363	50.5710	8.37494
1980- 6	779.300	4.61807	54.5041	7.77738
1980- 7	813.400	4.37572	57.4593	5.42198
1980- 8	880.500	8.24932	61.3654	6.79803
1980- 9	944.500	7.26860	64.0010	4.29493
1980- 10	1048.40	11.0005	71.2496	11.3258
1980- 11	1146.70	9.37619	79.2979	11.2959
1980- 12	1215.30	5.98238	85.0086	7.20158

1981- 1	1304.10	7.30684	88.6910	4.33180
1981- 2	1375.90	5.50571	94.9676	7.07693
1981- 3	1483.60	7.82760	101.384	6.75641
1981- 4	1595.50	7.54246	105.960	4.51353
1981- 5	1648.90	3.34691	121.889	15.0330
1981- 6	1694.00	2.73516	128.784	5.65679
1981- 7	1796.70	6.06257	135.673	5.34927
1981- 8	1866.80	3.90160	138.508	2.08958
1981- 9	2018.80	8.14228	148.711	7.36636
1981- 10	2200.80	9.01526	158.114	6.32300
1981- 11	2328.50	5.80244	170.505	7.83675
1981- 12	2448.70	5.16212	180.046	5.59573
1982- 1	2652.50	8.32278	189.490	5.24533

Source: ISCPI - Statistical Abstract of Israel No.33, 1982.

ISCPI is ISrael's CPI

PCISCPI is the Per Cent change in ISrael

EEREND is the Effective Exchange Rate in Israel END of month

PCEEREND is the Per Cent change in EEREND

Plot (App A.3) of the percent change in CPI-PCISCPI (A) and effective E.R.-PCEEREND (B). (Min value -7.7044 max value 53.88, spacing 1.2569).

```
         ++++++++++++++++++++++++++++++++++++++++++++++++++
1977-  9 +B    +  A                                       +
1977- 10 +     +  A                                       B
1977- 11 B     +         A                                +
1977- 12 +     +BA                                        +
1978-  1 +     + AB                                       +
1978-  2 +   B +A                                         +
1978-  3 +     +  A  B                                    +
1978-  4 +    B+    A                                     +
1978-  5 +     + A   B                                    +
1978-  6 +     + AB                                       +
1978-  7 +    B+ A                                        +
1978-  8 +     + &                                        + AB
1978-  9 +     +B A                                       +
1978- 10 +    B+    A                                     +
1978- 11 +     +    &                                     + AB
1978- 12 +     B  A                                       +
1979-  1 +   B +   A                                      +
1979-  2 +     + AB                                       +
1979-  3 +     +    A     B                               +
1979-  4 +     + B    A                                   +
1979-  5 +     +   A  B                                   +
1979-  6 +     +B A                                       +
1979-  7 +     + B  A                                     +
1979-  8 +     + B    A                                   +
1979-  9 +     +     &                                    + AB
1979- 10 +     +  B  A                                    +
1979- 11 +     +      BA                                  +
1979- 12 +     +   B  A                                   +
1980-  1 +     + B   A                                    +
1980-  2 +     +   A B                                    +
1980-  3 +     +   AB                                     +
1980-  4 +     +  B    A                                  +
1980-  5 +     +      BA                                  +
1980-  6 +     +   A B                                    +
1980-  7 +     +   &                                      + AB
1980-  8 +     +     BA                                   +
1980-  9 +     +   B A                                    +
1980- 10 +     +        &                                 + AB
1980- 11 +     +       AB                                 +
1980- 12 +     +    AB                                    +
1981-  1 +     +   B A                                    +
1981-  2 +     +    AB                                    +
1981-  3 +     +     &                                    + AB
1981-  4 +     +   B A                                    +
1981-  5 +     +  A        B                              +
1981-  6 +     + A  B                                     +
1981-  7 +     +   BA                                     +
1981-  8 +     + BA                                       +
1981-  9 +     +     BA                                   +
1981- 10 +     +    B A                                   +
1981- 11 +     +    AB                                    +
1981- 12 +     +   AB                                     +
1982-  1 +     +   B  A                                   +
         ++++++++++++++++++++++++++++++++++++++++++++++++++
```

Plot (App A.3) of the Israel CPI (A) and the E.R. (B).
(Min value 12.245, max value 2652.5, spacing 53.883).

```
         ++++++++++++++++++++++++++++++++++++++++++++++++++
1977-  9 B A                                              +
1977- 10 B A                                              +
1977- 11 B  A                                             +
1977- 12 B  A                                             +
1978-  1 B  A                                             +
1978-  2 B  A                                             +
1978-  3 B  A                                             +
1978-  4 B  A                                             +
1978-  5 B  A                                             +
1978-  6 B  A                                             +
1978-  7 B   A                                            +
1978-  8 B   A                                            +
1978-  9 B   A                                            +
1978- 10 B   A                                            +
1978- 11 B   A                                            +
1978- 12 B   A                                            +
1979-  1 B    A                                           +
1979-  2 B    A                                           +
1979-  3 B    A                                           +
1979-  4 B    A                                           +
1979-  5 B     A                                          +
1979-  6 B     A                                          +
1979-  7 B     A                                          +
1979-  8 B      A                                         +
1979-  9 B      A                                         +
1979- 10 B       A                                        +
1979- 11 B        A                                       +
1979- 12 B        A                                       +
1980-  1 +B        A                                      +
1980-  2 +B         A                                     +
1980-  3 +B         A                                     +
1980-  4 +B          A                                    +
1980-  5 +B            A                                  +
1980-  6 +B            A                                  +
1980-  7 +B             A                                 +
1980-  8 +B              A                                +
1980-  9 +B               A                               +
1980- 10 +B                 A                             +
1980- 11 +B                   A                           +
1980- 12 +B                    A                          +
1981-  1 +B                      A                        +
1981-  2 + B                      A                       +
1981-  3 + B                        A                     +
1981-  4 + B                          A                   +
1981-  5 + B                           A                  +
1981-  6 + B                            A                 +
1981-  7 + B                              A               +
1981-  8 + B                               A              +
1981-  9 +  B                                A           +
1981- 10 +  B                                    A       +
1981- 11 +  B                                      A     +
1981- 12 +  B                                        A   +
1982-  1 +  B                                            A
         ++++++++++++++++++++++++++++++++++++++++++++++++++
```

App B. (with table 2)

VAR results of lagged endogenous CPI

		Autoregresive equation of order 1	2	3	4	5	6
P(t-1)	A	.265 c	.288 b	.466 a	.474 a	.534 a	.574 a
	B	(1.87)	(2.19)	(3.15)	(2.88)	(3.36)	(3.27)
	C	.068	.034	.003	.006	.002	.003
P(t-2)	A		-.101	-.159	-.170	-.281	-.368 c
	B		(-.765)	(-.117)	(-.939)	(-1.58)	(-1.92)
	C		.448	.274	.353	.123	.064
P(t-3)	A			.037	.032	.344 c	.300
	B			(.280)	(.216)	(1.91)	(1.49)
	C			.781	.830	.064	.145
P(t-4)	A				.048	-.007	-.093
	B				(.332)	(-.052)	(-.471)
	C				.742	.959	.641
P(t-5)	A					.310 b	.308 b
	B					(2.23)	(2.13)
	C					.032	.041
P(t-6)	A						-.081
	B						(-.522)
	C						.605
CONST	A	2.94 a	2.37 b	2.20 b	2.05 c	1.41	1.56
	B	(3.17)	(2.57)	(2.28)	(1.92)	(1.35)	(1.41)
	C	.003	.014	.028	.062	.186	.167
Trend	A	.047 c	.079 a	.059 b	.055	-.027	.022
	B	(1.81)	(3.05)	(2.02)	(1.57)	(-.635)	(.392)
	C	.076	.004	.050	.124	.529	.698
R(sq)		.194	.332	.394	.348	.444	.460
R(sqbr)		.160	.286	.335	.263	.349	.342
SEE		2.45	2.18	2.09	2.17	2.00	2.02
D.W.		1.69	1.57	1.96	1.96	1.90	1.94
F(P)		3.49 c	2.41	3.33 b	2.20 c	3.74 a	2.82 b
sig		.068	.101	.028	.087	.008	.025
n		50	48	46	44	42	40
d.f.		47	44	41	38	35	32

A the coefficient
B the T-test
C significance of T-test

a significant at 1%
b significant at 5%
c significant at 10%

App C.
Exchange rate dependent variable explained by P and D2

		Equation with: 1 lag	2 lags	3 lags
P(t-2)	A		.377 c	.562 b
	B		(1.96)	(2.24)
	C		.056	.031
E(t-1)	A	-.170 a	-.349 b	-.331 c
	B	(-2.93)	(-2.53)	(-1.98)
	C	.005	.016	.056
E(t-2)	A		-.118 c	
	B		(-1.76)	
	C		.086	
D2(t-2)	A		2.66 b	2.43 c
	B		(2.29)	(1.75)
	C		.027	.089
CONST	A	-.182	-1.31	-.742
	B	(-.136)	(-.977)	(-.492)
	C	.892	.334	.626
TREND	A	.138 a	.151 a	.170 a
	B	(3.91)	(3.67)	(2.95)
	C	.0003	.0007	.006
R(sq)		.436	.479	.488
R(sqbr)		.385	.388	.342
SEE		3.27	3.01	3.12
D.W.		2.36	1.95	1.93
F(P)		2.53	3.93 b	2.86 c
sig		.119	.028	.051
F(E)		8.60 a	3.61 b	1.32
sig		.005	.036	.288
F(D2)		.448	2.76	1.28
sig		.507	.075	.298
n		50	48	46
d.f.		45	40	35

A the coefficient — a significant at 1%
B the T-test — b significant at 5%
C significance of T-test — c significant at 10%

App D.
E dependent variable explained by P, D2, D22P, D22E.

		Equations with: 1 lag	2 lags	3 lags
P(t-1)	A	.355 c	.411 c	
	B	(1.75)	(1.86)	
	C	.087	.071	
P(t-2)	A		.446 b	.602 b
	B		(2.27)	(2.20)
	C		.029	.036
E(t-1)	A	-.166 a	-.356 b	
	B	(-2.76)	(-2.18)	
	C	.008	.036	
D2(t-2)	A		8.60 b	-7.85 b
	B		(2.54)	(-2.14)
	C		.015	.041
CONST	A	-.531	-2.51 c	-2.31
	B	(-.377)	(-1.76)	(-1.37)
	C	.708	.086	.180
TREND	A	.138 a	.152 a	.150 b
	B	(3.81)	(3.73)	(2.45)
	C	.0004	.0006	.021
R(sq)		.446	.560	.593
R(sqbr)		.368	.425	.369
SEE		3.32	2.92	3.06
D.W.		2.42	2.01	2.08
F(P)		3.07 c	5.70 a	3.79 b
sig		.087	.007	.021
F(E)		7.59 a	2.46 c	1.14
sig		.009	.085	.350
F(D2)		1.08	3.84 b	2.78 c
sig		.304	.031	.059
F(D22P)		.709	1.69	1.48
sig		.404	.198	.239
F(D22E)		.039	1.26	.997
sig		.844	.294	.408

A the coefficient — a significant at 1%
B the T-test — b significant at 5%
C significance of T-test — c significant at 10%

App E.1.1

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (B)

ENTRY	E.R.	CPI	D1
In E.R.			
1	2.40550	0.140949	-0.378478E-01
2	-0.568557	0.276961	0.164184
3	0.393159	-0.747361E-01	-0.474356E-01
4	-0.546108	-0.327536	-0.904856E-01
5	-0.491293	0.106610E-02	0.577971E-01
6	0.321468	0.904396E-01	-0.592432E-02
7	0.230396	0.601873E-02	-0.206396E-01
8	-0.102528	0.548043E-01	0.412400E-01
9	0.819938E-01	-0.116652E-01	-0.134089E-01
10	-0.760249E-01	-0.676263E-01	-0.222055E-01
11	-0.121223	0.138960E-01	0.193863E-01
12	0.978715E-01	0.202092E-01	-0.353461E-02
13	0.347331E-01	-0.822813E-02	-0.721338E-02
14	-0.410846E-01	0.131047E-01	0.116290E-01
15	0.294613E-01	-0.125576E-02	-0.404493E-02
16	-0.132470E-01	-0.156573E-01	-0.560637E-02
17	-0.301727E-01	0.593971E-02	0.606690E-02
18	0.275297E-01	0.431025E-02	-0.153480E-02
19	0.463773E-02	-0.406985E-02	-0.224191E-02
20	-0.135732E-01	0.360445E-02	0.339150E-02
21	0.102331E-01	0.113979E-04	-0.125102E-02
22	-0.271430E-02	-0.391391E-02	-0.145600E-02
23	-0.801948E-02	0.202395E-02	0.184253E-02
24	0.783088E-02	0.897444E-03	-0.571035E-03

App E.1.2

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (B)

ENTRY	E.R.	CPI	D1
In P:			
1	0.000000E+00	1.83367	0.813875E-01
2	-0.235305E-01	0.835326	-0.232780E-01
3	1.40140	0.164895	-0.634688E-01
4	-0.504564	0.823977E-01	0.422715E-01
5	0.261856E-01	-0.114891E-01	-0.344990E-01
6	-0.162597	-0.705602E-01	-0.402502E-01
7	-0.523834E-01	0.781279E-01	0.342134E-01
8	0.223903	0.733495E-01	0.120958E-02
9	0.815063E-01	-0.111911E-01	-0.136158E-01
10	-0.112138	0.273094E-02	0.146372E-01
11	0.109237E-01	-0.955091E-02	-0.685588E-02
12	-0.148957E-01	-0.218344E-01	-0.943165E-02
13	-0.304095E-01	0.161222E-01	0.103994E-01
14	0.535889E-01	0.122259E-01	-0.928976E-03
15	0.989850E-02	-0.763900E-02	-0.416469E-02
16	-0.301730E-01	0.193327E-02	0.468059E-02
17	0.988404E-02	-0.877241E-03	-0.179728E-02
18	-0.166823E-02	-0.557109E-02	-0.246216E-02
19	-0.100060E-01	0.413998E-02	0.302882E-02
20	0.134829E-01	0.231222E-02	-0.567107E-03
21	0.101768E-02	-0.264402E-02	-0.122182E-02
22	-0.817151E-02	0.983255E-03	0.145630E-02
23	0.425182E-02	0.722611E-04	-0.527831E-03
24	-0.291469E-03	-0.151270E-02	-0.664296E-03

App E.1.3

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (B)

ENTRY	E.R.	CPI	D1
In D1:			
1	0.000000E+00	0.000000E+00	0.265597
2	0.705061	-0.395818	-0.117084
3	-1.07730	-0.503536	-0.788484E-01
4	-0.687387	0.282714E-01	0.103368
5	0.591375	0.445341E-01	-0.476025E-01
6	0.127300	-0.790147E-02	-0.728324E-02
7	-0.104539	0.102808	0.673205E-01
8	0.185073	-0.472819E-01	-0.400685E-01
9	-0.191446	-0.928300E-01	-0.187111E-01
10	-0.142289	0.370059E-01	0.320221E-01
11	0.173529	0.109289E-01	-0.170053E-01
12	-0.328938E-02	-0.112892E-01	-0.351631E-02
13	-0.427070E-01	0.277025E-01	0.186152E-01
14	0.618951E-01	-0.103822E-01	-0.120178E-01
15	-0.446922E-01	-0.207144E-01	-0.404364E-02
16	-0.329978E-01	0.134892E-01	0.967123E-02
17	0.487529E-01	0.983781E-03	-0.563956E-02
18	-0.861902E-02	-0.520753E-02	-0.105923E-02
19	-0.138637E-01	0.778337E-02	0.531900E-02
20	0.199778E-01	-0.261802E-02	-0.361721E-02
21	-0.117153E-01	-0.502997E-02	-0.856644E-03
22	-0.820305E-02	0.429763E-02	0.285755E-02
23	0.137849E-01	-0.253100E-03	-0.181672E-02
24	-0.403267E-02	-0.180015E-02	-0.265945E-03

App E.2

COVARIANCE MATRIX

VARIABLE	CPI	E.R.	D1
CPI	3.3822	0.33905	0.14390
E.R.	0.33905	5.7864	-0.91043E-01
D1	0.14390	-0.91043E-01	0.78598E-01

CORRELATION MATRIX

VARIABLE	CPI	E.R.	D1
CPI	1.0000	0.76641E-01	0.27910
E.R..	0.76641E-01	1.0000	-0.13500
D1	0.27910	-0.13500	1.0000

App E.3.1

DECOMPOSITION OF VARIANCE model B

STEP	STAN ERR	E.R.	CPI	D1
In Exchange rate:				
1	2.40550	100.000000	0.000000	0.000000
2	2.57048	92.468021	0.008380	7.523599
3	3.14427	63.362324	19.870387	16.767290
4	3.30329	60.141642	20.336396	19.521962
5	3.39168	59.145976	19.296186	21.557839
6	3.41314	59.291885	19.281320	21.426795
7	3.42290	59.407128	19.194883	21.397988
8	3.43674	59.018823	19.465113	21.516064
9	3.44400	58.826625	19.439038	21.734337
10	3.44960	58.684372	19.481654	21.833974
11	3.45611	58.586672	19.409378	22.003950
12	3.45753	58.618715	19.395304	21.985981
13	3.45810	58.609417	19.396622	21.993961
14	3.45931	58.582427	19.407019	22.010553
15	3.45974	58.575176	19.403033	22.021791
16	3.46006	58.566001	19.407113	22.026886
17	3.46055	58.557049	19.402444	22.040507
18	3.46067	58.559295	19.401114	22.039591
19	3.46071	58.557940	19.401442	22.040618
20	3.46082	58.555737	19.401720	22.042542
21	3.46086	58.555424	19.401335	22.043241
22	3.46088	58.554794	19.401664	22.043543
23	3.46092	58.553999	19.401373	22.044628
24	3.46093	58.554131	19.401248	22.044621

App E.3.2

DECOMPOSITION OF VARIANCE model B

STEP	STAN ERR	E.R.	CPI	D1
In CPI:				
1	1.83908	0.587390	99.412610	0.000000
2	2.07686	2.238962	94.128789	3.632249
3	2.14469	2.221021	88.860519	8.918460
4	2.17130	4.442415	86.839467	8.718118
5	2.17179	4.440445	86.803300	8.756254
6	2.17483	4.600962	86.665938	8.733100
7	2.17867	4.585528	86.489439	8.925032
8	2.18110	4.638428	86.409469	8.952103
9	2.18314	4.632643	86.251125	9.116233
10	2.18450	4.722702	86.143735	9.133563
11	2.18459	4.726348	86.138359	9.135293
12	2.18482	4.733902	86.130073	9.136025
13	2.18508	4.734234	86.115763	9.150003
14	2.18517	4.737405	86.111157	9.151438
15	2.18529	4.736953	86.103561	9.159486
16	2.18538	4.741659	86.095871	9.162470
17	2.18539	4.742361	86.095220	9.162419
18	2.18541	4.742674	86.094487	9.162840
19	2.18543	4.742927	86.093146	9.163927
20	2.18544	4.743174	86.092804	9.164022
21	2.18544	4.743142	86.092368	9.164490
22	2.18545	4.743428	86.091762	9.164810
23	2.18545	4.743510	86.091687	9.164803
24	2.18545	4.743520	86.091621	9.164859

App E.3.3

DECOMPOSITION OF VARIANCE model B

STEP	STAN ERR	E.R.	CPI	D1
In D1:				
1	0.280354	1.822497	8.427572	89.749931
2	0.346129	23.695891	5.981193	70.322916
3	0.363732	23.158642	8.461078	68.380280
4	0.391102	25.383514	8.486481	66.130005
5	0.399696	26.394591	8.870427	64.734982
6	0.401828	26.137087	9.779940	64.082973
7	0.409383	25.435484	10.120754	64.443762
8	0.413403	25.938353	9.925730	64.135917
9	0.414267	25.935011	9.992385	64.072604
10	0.416353	25.960217	10.016098	64.023685
11	0.417207	26.069941	10.002130	63.927929
12	0.417344	26.060383	10.046626	63.892991
13	0.417951	26.014576	10.079393	63.906030
14	0.418286	26.050159	10.063726	63.886115
15	0.418346	26.052057	10.070758	63.877185
16	0.418522	26.048157	10.074821	63.877022
17	0.418608	26.058482	10.072534	63.868984
18	0.418619	26.058408	10.075445	63.866147
19	0.418670	26.054958	10.078236	63.866806
20	0.418699	26.057817	10.076988	63.865195
21	0.418704	26.058147	10.077621	63.864232
22	0.418719	26.057512	10.078118	63.864370
23	0.418727	26.058412	10.077876	63.863713
24	0.418728	26.058473	10.078079	63.863448

App E.4.1

Plot of responses to 1 SD innovation.

Plot of responses to 1 SD innovation in E.R. on:

a. E.R. (column 1) with min value -0.56856 and max value 2.4055 spacing 0.60695E-01.

```
     ++++++++++++++++++++++++++++++++++++++++++++++++++
  1  +        +                                       A
  2  A        +                                       +
  3  +        +      A                                +
  4  A        +                                       +
  5  +A       +                                       +
  6  +        +     A                                 +
  7  +        +   A                                   +
  8  +       A+                                       +
  9  +        + A                                     +
 10  +       A+                                       +
 11  +      A +                                       +
 12  +        + A                                     +
 13  +        +A                                      +
 14  +        A                                       +
 15  +        +A                                      +
 16  +        A                                       +
 17  +        A                                       +
 18  +        +A                                      +
 19  +        A                                       +
 20  +        A                                       +
 21  +        +A                                      +
 22  +        A                                       +
 23  +        A                                       +
 24  +        A                                       +
     ++++++++++++++++++++++++++++++++++++++++++++++++++
```

b. CPI (column 2) with min value -0.32754 and max value 0.27696 spacing 0.12337E-01.

```
    ++++++++++++++++++++++++++++++++++++++++++++++++++
 1  +                          +          A          +
 2  +                          +                     A
 3  +                   A      +                     +
 4  A                          +                     +
 5  +                          A                     +
 6  +                          +      A              +
 7  +                          A                     +
 8  +                          +   A                 +
 9  +                         A+                     +
10  +                    A     +                     +
11  +                          +A                    +
12  +                          +A                    +
13  +                         A+                     +
14  +                          +A                    +
15  +                         A+                     +
16  +                        A +                     +
17  +                          A                     +
18  +                          A                     +
19  +                         A+                     +
20  +                          A                     +
21  +                          A                     +
22  +                         A+                     +
23  +                          A                     +
24  +                          A                     +
    ++++++++++++++++++++++++++++++++++++++++++++++++++
```

c. D1 (column 3) with min value -0.90486E-01 max value 0.16418 and spacing of 0.51973E-02.

```
    +++++++++++++++++++++++++++++++++++++++++++++++++++
 1  +         A      +                                +
 2  +                +                                A
 3  +       A        +                                +
 4  A                +                                +
 5  +                +           A                    +
 6  +               A+                                +
 7  +            A   +                                +
 8  +                +       A                        +
 9  +              A +                                +
10  +            A   +                                +
11  +                +   A                            +
12  +                A                                +
13  +               A+                                +
14  +                +  A                             +
15  +                A                                +
16  +               A+                                +
17  +                + A                              +
18  +                A                                +
19  +                A                                +
20  +                +A                               +
21  +                A                                +
22  +                A                                +
23  +                +A                               +
24  +                A                                +
    +++++++++++++++++++++++++++++++++++++++++++++++++++
```

App E.4.2:

plot of responses to 1 SD innovation in CPI on:

a. E.R. (column 1) with min value -0.50456 max value 1.4014 and spacing of 0.38897E-01.

```
       ++++++++++++++++++++++++++++++++++++++++++++++++++
   1   +            A                                   +
   2   +           A+                                   +
   3   +            +                                   A
   4   A            +                                   +
   5   +            +A                                  +
   6   +        A   +                                   +
   7   +           A+                                   +
   8   +            +     A                             +
   9   +            + A                                 +
  10   +         A  +                                   +
  11   +            A                                   +
  12   +            A                                   +
  13   +           A+                                   +
  14   +            +A                                  +
  15   +            A                                   +
  16   +           A+                                   +
  17   +            A                                   +
  18   +            A                                   +
  19   +            A                                   +
  20   +            A                                   +
  21   +            A                                   +
  22   +            A                                   +
  23   +            A                                   +
  24   +            A                                   +
       ++++++++++++++++++++++++++++++++++++++++++++++++++
```

b. CPI (column 2) with min value -0.70560E-01 max value 1.8337 and spacing 0.38862E-01.

```
    ++++++++++++++++++++++++++++++++++++++++++++++++++
 1  + +                                              A
 2  + +                    A                         +
 3  + +   A                                          +
 4  + + A                                            +
 5  + A                                              +
 6  A +                                              +
 7  + + A                                            +
 8  + + A                                            +
 9  + A                                              +
10  + A                                              +
11  + A                                              +
12  +A+                                              +
13  + A                                              +
14  + A                                              +
15  + A                                              +
16  + A                                              +
17  + A                                              +
18  + A                                              +
19  + A                                              +
20  + A                                              +
21  + A                                              +
22  + A                                              +
23  + A                                              +
24  + A                                              +
    ++++++++++++++++++++++++++++++++++++++++++++++++++
```

c. D1 (column 3) with min value -0.63469E-01 max value 0.81387E-01 and spacing 0.29563E-02.

```
    ++++++++++++++++++++++++++++++++++++++++++++++++++
  1 +                    +                           A
  2 +             A      +                           +
  3 A                    +                           +
  4 +                    +              A            +
  5 +         A          +                           +
  6 +       A            +                           +
  7 +                    +           A               +
  8 +                    +A                          +
  9 +                A   +                           +
 10 +                    +    A                      +
 11 +                  A +                           +
 12 +                 A  +                           +
 13 +                    +   A                       +
 14 +                    A                           +
 15 +                   A+                           +
 16 +                    + A                         +
 17 +                    A                           +
 18 +                    A                           +
 19 +                    +A                          +
 20 +                    A                           +
 21 +                    A                           +
 22 +                    +A                          +
 23 +                    A                           +
 24 +                    A                           +
    ++++++++++++++++++++++++++++++++++++++++++++++++++
```

App E.4.3:

Plot of responses to 1 SD innovation in D1 on:

a. on E.R. (column 1) with min value -1.0773 max value 0.70506 and spacing 0.36375E-01.

```
     ++++++++++++++++++++++++++++++++++++++++++++++++++
  1  +                             A                  +
  2  +                             +                  A
  3  A                             +                  +
  4  +          A                  +                  +
  5  +                             +               A  +
  6  +                             +  A               +
  7  +                          A  +                  +
  8  +                             +    A             +
  9  +                       A     +                  +
 10  +                         A   +                  +
 11  +                             +   A              +
 12  +                             A                  +
 13  +                           A +                  +
 14  +                             +A                 +
 15  +                           A +                  +
 16  +                            A+                  +
 17  +                             +A                 +
 18  +                            A+                  +
 19  +                            A+                  +
 20  +                             A                  +
 21  +                            A+                  +
 22  +                            A+                  +
 23  +                             A                  +
 24  +                             A                  +
     ++++++++++++++++++++++++++++++++++++++++++++++++++
```

b. CPI (column 2) with min value -0.50354 max value 0.10281 and spacing 0.12374E-01.

```
      ++++++++++++++++++++++++++++++++++++++++++++++++++
   1  +                                        A       +
   2  +        A                               +       +
   3  A                                        +       +
   4  +                                        + A     +
   5  +                                        +  A    +
   6  +                                       A+       +
   7  +                                        +       A
   8  +                                    A   +       +
   9  +                                A       +       +
  10  +                                        +  A    +
  11  +                                        +A      +
  12  +                                       A+       +
  13  +                                        + A     +
  14  +                                       A+       +
  15  +                                      A +       +
  16  +                                        +A      +
  17  +                                        A       +
  18  +                                       A+       +
  19  +                                        A       +
  20  +                                       A+       +
  21  +                                       A+       +
  22  +                                        A       +
  23  +                                        A       +
  24  +                                        A       +
      ++++++++++++++++++++++++++++++++++++++++++++++++++
```

c. D1 (column 3) with min value -0.11708 max value 0.26560 and spacing 0.78098E-02.

```
     ++++++++++++++++++++++++++++++++++++++++++++++++++
   1 +              +                                 A
   2 A              +                                 +
   3 +    A         +                                 +
   4 +              +            A                    +
   5 +        A     +                                 +
   6 +             A+                                 +
   7 +              +        A                        +
   8 +         A    +                                 +
   9 +            A +                                 +
  10 +              +   A                             +
  11 +            A +                                 +
  12 +              A                                 +
  13 +              + A                               +
  14 +            A +                                 +
  15 +             A+                                 +
  16 +              +A                                +
  17 +             A+                                 +
  18 +              A                                 +
  19 +              +A                                +
  20 +              A                                 +
  21 +              A                                 +
  22 +              A                                 +
  23 +              A                                 +
  24 +              A                                 +
     ++++++++++++++++++++++++++++++++++++++++++++++++++
```

App F.1.1

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (C)

ENTRY	E.R.	CPI	D2HAT
In E.R.:			
1	2.70359	-0.124507	0.917424E-02
2	-0.958839	-0.493233E-01	-0.141144
3	-0.118766	-0.109122	-0.342872E-01
4	-0.160990	-0.381955	0.277753E-01
5	-0.221299	-0.909876E-01	0.388568E-01
6	-0.414743E-01	0.131129	0.127604E-01
7	0.262982	0.135028	-0.167661E-01
8	0.685259E-01	0.200456E-01	-0.291983E-01
9	-0.718022E-01	-0.806672E-01	-0.950566E-02
10	-0.112230	-0.931174E-01	0.127179E-01
11	-0.504633E-01	-0.147347E-01	0.165136E-01
12	0.367171E-01	0.546325E-01	0.415885E-02
13	0.731701E-01	0.530815E-01	-0.841628E-02
14	0.275444E-01	0.343774E-02	-0.100487E-01
15	-0.298632E-01	-0.352829E-01	-0.205672E-02
16	-0.435932E-01	-0.315416E-01	0.558561E-02
17	-0.141376E-01	-0.147294E-03	0.598664E-02
18	0.196822E-01	0.226571E-01	0.814729E-03
19	0.264183E-01	0.184134E-01	-0.365186E-02
20	0.710195E-02	-0.144164E-02	-0.355488E-02
21	-0.133319E-01	-0.144410E-01	-0.249105E-03
22	-0.159083E-01	-0.106804E-01	0.236301E-02
23	-0.328242E-02	0.175326E-02	0.209482E-02
24	0.879861E-02	0.912720E-02	-0.690497E-05

App F.1.2

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (C)

ENTRY	E.R.	CPI	D2HAT
In CPI:			
1	0.000000E+00	1.81151	0.532504E-02
2	0.232957	0.744244	0.244684E-01
3	1.17316	0.127127	0.839902E-01
4	-0.506122	0.119413	0.556202E-01
5	0.235950	0.267113	0.611900E-01
6	0.317542	0.219885	0.138849E-01
7	0.212441	0.163748	-0.188251E-01
8	0.205611E-01	0.126447E-01	-0.158720E-01
9	-0.393300E-01	-0.770465E-01	0.623880E-02
10	-0.887475E-01	-0.445391E-01	0.172656E-01
11	0.207346E-02	0.335130E-01	0.122940E-01
12	0.701629E-01	0.628998E-01	-0.175129E-02
13	0.574040E-01	0.331163E-01	-0.986168E-02
14	-0.172894E-02	-0.160048E-01	-0.636320E-02
15	-0.383071E-01	-0.357976E-01	0.221641E-02
16	-0.308656E-01	-0.164873E-01	0.642904E-02
17	0.369844E-02	0.131204E-01	0.370355E-02
18	0.257772E-01	0.227018E-01	-0.159138E-02
19	0.183227E-01	0.914940E-02	-0.394517E-02
20	-0.370319E-02	-0.883309E-02	-0.203782E-02
21	-0.160381E-01	-0.137148E-01	0.120523E-02
22	-0.103384E-01	-0.471308E-02	0.244983E-02
23	0.320865E-02	0.610111E-02	0.111956E-02
24	0.100841E-01	0.835545E-02	-0.857561E-03

App F.1.3

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (C)

ENTRY	E.R.	CPI	D2HAT
In D2HAT:			
1	0.000000E+00	0.000000E+00	0.131747
2	0.515138	0.963660E-01	0.656761E-01
3	0.629264E-01	0.406854	-0.157780E-01
4	0.346794	0.181860	-0.410852E-01
5	0.732503E-01	-0.927535E-01	-0.237512E-01
6	-0.232968	-0.155467	0.114296E-01
7	-0.129425	-0.584689E-01	0.319439E-01
8	0.455526E-01	0.671176E-01	0.170952E-01
9	0.119825	0.109380	-0.886532E-02
10	0.807463E-01	0.405088E-01	-0.186354E-01
11	-0.185435E-01	-0.455724E-01	-0.859210E-02
12	-0.778633E-01	-0.640116E-01	0.643336E-02
13	-0.460982E-01	-0.185576E-01	0.116116E-01
14	0.192792E-01	0.310739E-01	0.480136E-02
15	0.482454E-01	0.390122E-01	-0.448775E-02
16	0.255977E-01	0.933077E-02	-0.707216E-02
17	-0.137629E-01	-0.205834E-01	-0.248370E-02
18	-0.297939E-01	-0.233500E-01	0.308550E-02
19	-0.141540E-01	-0.404696E-02	0.429891E-02
20	0.100725E-01	0.135607E-01	0.126219E-02
21	0.183564E-01	0.139257E-01	-0.207803E-02
22	0.761948E-02	0.151539E-02	-0.259448E-02
23	-0.704975E-02	-0.881698E-02	-0.603673E-03
24	-0.112158E-01	-0.823964E-02	0.138215E-02

App F.2

CCVARIANCE MATRIX

VARIABLE	CPI	E.R.	D2HAT
CPI	3.2971	-0.33662	0.85041E-02
E.R.	-0.33662	7.3094	0.24803E-01
D2HAT	0.85041E-02	0.24803E-01	0.17470E-01

CORRELATION MATRIX

CPI	1.0000	-0.68569E-01	0.35434E-01
E.R.	-0.68569E-01	1.0000	0.69410E-01
D2HAT	0.35434E-01	0.69410E-01	1.0000

App F.3.1

DECOMPOSITION OF VARIANCE

STEP	STAN ERR	E.R.	CPI	D2HAT
In E.R.:				
1	2.70359	100.000000	0.000000	0.000000
2	2.92377	96.260864	0.634842	3.104293
3	3.15322	82.903205	14.388019	2.708776
4	3.21638	79.929454	16.304578	3.765968
5	3.23344	79.556833	16.665505	3.777662
6	3.25760	78.397321	17.369401	4.233278
7	3.27765	78.084804	17.577631	4.337565
8	3.27875	78.076234	17.569801	4.353965
9	3.28196	77.971440	17.549809	4.478752
10	3.28607	77.893184	17.578880	4.527936
11	3.28651	77.895885	17.574208	4.529907
12	3.28838	77.819506	17.599688	4.580806
13	3.29002	77.791508	17.612613	4.595879
14	3.29019	77.790372	17.610797	4.598831
15	3.29091	77.764942	17.616725	4.618333
16	3.29144	77.757300	17.619814	4.622886
17	3.29150	77.756253	17.619285	4.624462
18	3.29179	77.745910	17.622263	4.631826
19	3.29198	77.743498	17.623355	4.633148
20	3.29201	77.742775	17.623212	4.634013
21	3.29212	77.738878	17.624330	4.636792
22	3.29219	77.738215	17.624636	4.637149
23	3.29220	77.737807	17.624616	4.637577
24	3.29224	77.736334	17.625059	4.638607

App F.3.2

DECOMPOSITION OF VARIANCE

STEP	STAN ERR	E.R.	CPI	D2HAT
In CPI:				
1	1.81578	0.470173	99.529827	0.000000
2	1.96537	0.464307	99.295281	0.240413
3	2.01402	0.735708	94.954525	4.309768
4	2.06144	4.135340	90.972572	4.892088
5	2.08273	4.242079	90.767006	4.990915
6	2.10415	4.544489	90.019816	5.435696
7	2.11564	4.902629	89.644154	5.453217
8	2.11684	4.906053	89.546365	5.547582
9	2.12259	5.023907	89.193017	5.783076
10	2.12549	5.202164	88.994176	5.803660
11	2.12629	5.203034	88.951756	5.845210
12	2.12888	5.256218	88.822399	5.921382
13	2.12988	5.313396	88.763189	5.923415
14	2.13017	5.312212	88.744704	5.943084
15	2.13112	5.334887	88.693816	5.971298
16	2.13144	5.355196	88.673370	5.971435
17	2.13158	5.354494	88.665530	5.979976
18	2.13195	5.363934	88.646165	5.989901
19	2.13205	5.370874	88.639443	5.989682
20	2.13212	5.370608	88.636012	5.993380
21	2.13225	5.374498	88.628636	5.996867
22	2.13229	5.376843	88.626423	5.996734
23	2.13231	5.376771	88.624941	5.998289
24	2.13237	5.378341	88.622168	5.999490

App F.3.3

DECOMPOSITION OF VARIANCE

STEP	STAN ERR	E.R.	CPI	D2HAT
In D2HAT:				
1	0.132174	0.481781	0.162314	99.355905
2	0.205678	47.291047	1.482278	51.226675
3	0.225350	41.710070	15.126114	43.163816
4	0.237351	38.968069	19.126502	41.905429
5	0.249307	37.749498	23.360205	38.890297
6	0.250280	37.716403	23.486644	38.796953
7	0.253566	37.182240	23.432940	39.384820
8	0.256306	37.689475	23.318210	38.992315
9	0.256711	37.707701	23.303718	38.988581
10	0.258278	37.493926	23.468635	39.037440
11	0.259240	37.622049	23.519742	38.858209
12	0.259359	37.613224	23.502710	38.884066
13	0.259942	37.549434	23.541276	38.909289
14	0.260258	37.607307	23.543875	38.848818
15	0.260315	37.597298	23.540951	38.861751
16	0.260550	37.575386	23.559340	38.865274
17	0.260657	37.597318	23.560205	38.842476
18	0.260681	37.591259	23.559523	38.849218
19	0.260772	37.584679	23.565996	38.849326
20	0.260807	37.593100	23.565732	38.841168
21	0.260819	37.589967	23.565847	38.844186
22	0.260854	37.588055	23.568323	38.843622
23	0.260865	37.591186	23.568085	38.840729
24	0.260870	37.589724	23.568249	38.842026

App G.1

COVARIANCE MATRIX 1 TO 3 LAGS

VARIABLE	CPI	E.R.	D1	D2HAT
CPI	2.9766	0.86801E-02	0.12144	0.59740E-02
E.R.	0.86801E-02	5.4383	-0.84302E-01	0.36410E-01
D1	0.12144	-0.84302E-01	0.59757E-01	-0.24313E-02
D2HAT	0.59740E-02	0.36410E-01	-0.24313E-02	0.11480E-01

CORRELATION MATRIX

CPI	1.0000	0.21574E-02	0.28794	0.32317E-01
E.R.	0.21574E-02	1.0000	-0.14788	0.14572
D1	0.28794	-0.14788	1.0000	-0.92827E-01
D2HAT	0.32317E-01	0.14572	-0.92827E-01	1.0000

App G.2.1

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (D)

ENTRY	E.R.	CPI	D1	D2HAT
In E.R.:				
1	2.33203	0.372214E-02	-0.361498E-01	0.156128E-01
2	-0.566537	0.591837E-01	0.117658	-0.905146E-01
3	0.162493	-0.174632	-0.571230E-01	-0.379884E-01
4	-0.628738	-0.368111	-0.443428E-01	-0.418400E-02
5	-0.149209	-0.410519E-01	0.139428E-01	0.526767E-01
6	0.899792E-01	0.628986E-01	-0.531876E-02	0.264221E-01
7	0.299569	0.136259	0.373703E-02	-0.151809E-01
8	-0.777876E-02	0.115288	0.439262E-01	-0.299274E-01
9	0.103140	-0.808148E-01	-0.190641E-01	-0.156836E-01
10	-0.184984	-0.152430	-0.275022E-01	-0.526941E-03
11	-0.189131	-0.205685E-01	0.100697E-01	0.219351E-01
12	0.833002E-01	0.331048E-01	-0.295946E-02	0.172951E-01
13	0.126927	0.589791E-01	-0.365385E-03	-0.593369E-02
14	0.112001E-01	0.665419E-01	0.213074E-01	-0.138069E-01
15	0.402626E-01	-0.272484E-01	-0.526759E-02	-0.819123E-02
16	-0.614834E-01	-0.746684E-01	-0.154878E-01	-0.988479E-03
17	-0.107143	-0.152646E-01	0.445670E-02	0.947076E-02
18	0.315110E-01	0.156834E-01	-0.376952E-03	0.933334E-02
19	0.643257E-01	0.253614E-01	-0.166000E-02	-0.187655E-02
20	0.731859E-02	0.340809E-01	0.101832E-01	-0.655183E-02
21	0.184357E-01	-0.728441E-02	-0.685967E-03	-0.415691E-02
22	-0.205440E-01	-0.363961E-01	-0.819453E-02	-0.946158E-03
23	-0.552500E-01	-0.102225E-01	0.162803E-02	0.402375E-02
24	0.859450E-02	0.714787E-02	0.469761E-03	0.483877E-02

App G.2.2

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (D)

ENTRY	E.R.	CPI	D1	D2HAT
In CPI:				
1	0.000000E+00	1.72528	0.704645E-01	0.342897E-02
2	0.332878E-02	0.776719	-0.622486E-01	0.224260E-01
3	1.20180	0.120196	-0.600427E-01	0.102098
4	-0.339743	0.171491	0.557941E-01	0.786452E-01
5	0.251080	0.203756	-0.339912E-01	0.447817E-01
6	-0.518031E-01	0.217591	0.231144E-01	-0.714737E-02
7	0.192412	0.217909	0.480910E-01	-0.894622E-02
8	0.128864	-0.486828E-01	-0.294816E-01	-0.161443E-01
9	-0.159901	-0.940475E-01	-0.189315E-01	-0.255412E-02
10	-0.216435	0.127996E-02	0.189906E-01	0.226477E-01
11	0.145672	0.379379E-02	-0.188508E-01	0.187776E-01
12	0.427410E-01	0.585420E-01	0.341526E-02	-0.467151E-02
13	0.192714E-01	0.902348E-01	0.275641E-01	-0.846619E-02
14	0.912009E-01	-0.289244E-01	-0.123402E-01	-0.848577E-02
15	-0.724001E-01	-0.632434E-01	-0.120718E-01	-0.411740E-02
16	-0.117502	-0.626058E-02	0.960672E-02	0.911703E-02
17	0.539312E-01	-0.252149E-02	-0.762340E-02	0.937547E-02
18	0.338604E-01	0.200321E-01	-0.140296E-02	-0.160647E-02
19	-0.545959E-03	0.441454E-01	0.141470E-01	-0.430182E-02
20	0.467650E-01	-0.839373E-02	-0.410180E-02	-0.398534E-02
21	-0.249074E-01	-0.329703E-01	-0.728884E-02	-0.262581E-02
22	-0.620854E-01	-0.481291E-02	0.468691E-02	0.373240E-02
23	0.197865E-01	-0.118744E-02	-0.276504E-02	0.486242E-02
24	0.209907E-01	0.676333E-02	-0.199874E-02	-0.369196E-03

App G.2.3

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (D)

ENTRY	E.R.	CPI	D1	D2HAT
In D1:				
1	0.000000E+00	0.000000E+00	0.231268	-0.911731E-02
2	0.815767	-0.162906	-0.113567	-0.702900E-01
3	-0.983994	-0.236214	-0.441274E-01	-0.947013E-01
4	-0.433647	0.186787E-01	0.952080E-01	0.417696E-01
5	0.428834	-0.245403	-0.966413E-01	0.512398E-01
6	-0.261448E-01	-0.942066E-02	-0.325734E-01	-0.285405E-02
7	-0.243858	0.325022	0.122355	-0.167289E-02
8	0.583347	-0.149357E-01	-0.425411E-01	-0.137190E-01
9	-0.999683E-01	-0.154841	-0.415202E-01	-0.352935E-01
10	-0.424909	0.295828E-01	0.580251E-01	0.103759E-01
11	0.171131	-0.853006E-01	-0.380684E-01	0.268890E-01
12	0.335686E-01	-0.365025E-01	-0.288171E-01	0.398977E-03
13	-0.133014	0.159562	0.595607E-01	-0.409414E-03
14	0.252096	0.183954E-01	-0.110703E-01	-0.464752E-02
15	0.143174E-01	-0.805102E-01	-0.275170E-01	-0.170659E-01
16	-0.226809	0.123638E-01	0.286060E-01	0.229363E-02
17	0.650782E-01	-0.317191E-01	-0.127690E-01	0.138082E-01
18	0.380170E-01	-0.297349E-01	-0.195727E-01	0.957683E-03
19	-0.772034E-01	0.738333E-01	0.280009E-01	-0.517459E-03
20	0.109379	0.202386E-01	-0.497619E-03	-0.122814E-02
21	0.330624E-01	-0.411521E-01	-0.163058E-01	-0.819645E-02
22	-0.114896	0.391357E-02	0.131954E-01	-0.272137E-03
23	0.190575E-01	-0.105066E-01	-0.302053E-02	0.687475E-02
24	0.300243E-01	-0.194953E-01	-0.118604E-01	0.953995E-03

App G.2.4

RESPONSES TO ONE-STANDARD DEVIATION SHOCK (D)

ENTRY	E.R.	CPI	D1	D2HAT
In D2HAT:				
1	0.000000E+00	0.000000E+00	0.000000E+00	0.105553
2	0.291585	0.125170	-0.116836E-02	0.338558E-01
3	0.101395	0.317727	0.164095E-01	-0.167956E-01
4	0.553347E-01	0.173031	0.454262E-01	-0.287288E-01
5	0.200657	-0.836072E-01	-0.277845E-01	-0.104100E-01
6	-0.254411	-0.146502	-0.250785E-01	0.281270E-02
7	-0.190987	-0.319329E-02	0.101489E-01	0.279900E-01
8	0.104217	0.450654E-01	-0.414606E-02	0.191940E-01
9	0.144945	0.800531E-01	0.298866E-02	-0.707126E-02
10	0.159744E-01	0.748639E-01	0.231896E-01	-0.158292E-01
11	0.447483E-01	-0.370451E-01	-0.833039E-02	-0.917601E-02
12	-0.850541E-01	-0.821442E-01	-0.157018E-01	-0.109253E-03
13	-0.111830	-0.147834E-01	0.469385E-02	0.117628E-01
14	0.415451E-01	0.188489E-01	-0.121991E-02	0.101122E-01
15	0.695078E-01	0.331185E-01	-0.179209E-03	-0.265818E-02
16	0.117852E-01	0.376715E-01	0.112643E-01	-0.756083E-02
17	0.202578E-01	-0.124603E-01	-0.206659E-02	-0.482948E-02
18	-0.310577E-01	-0.407605E-01	-0.849755E-02	-0.701867E-03
19	-0.594932E-01	-0.105498E-01	0.185973E-02	0.506137E-02
20	0.137038E-01	0.821518E-02	-0.785980E-05	0.530483E-02
21	0.355264E-01	0.142268E-01	-0.867223E-03	-0.727009E-03
22	0.623216E-02	0.189647E-01	0.535226E-02	-0.359023E-02
23	0.970588E-02	-0.288727E-02	-0.284285E-04	-0.243831E-02
24	-0.104484E-01	-0.197486E-01	-0.441178E-02	-0.610807E-03

App G.3.1

DECOMPOSITION OF VARIANCE

STEP	STAN ERR	PCDTSA	PCISCPI	D1	D2HAT
E.R.:					
1	2.33203	100.000000	0.000000	0.000000	0.000000
2	2.55143	88.471130	0.000170	10.222646	1.306053
3	2.99317	64.579326	16.121563	18.235356	1.063755
4	3.10820	63.979620	16.145124	18.857087	1.018169
5	3.15759	62.217078	16.276288	20.116240	1.390394
6	3.16963	61.825842	16.179567	19.970492	2.024098
7	3.20457	61.358928	16.189200	20.116474	2.335398
8	3.26146	59.237762	15.785505	22.619985	2.356748
9	3.27175	58.965207	15.925253	22.571322	2.538218
10	3.31152	57.869191	15.972137	23.678738	2.479934
11	3.32483	57.730641	16.036549	23.754567	2.478244
12	3.32740	57.704010	16.028241	23.727999	2.539750
13	3.33441	57.606639	15.964287	23.787507	2.641567
14	3.34544	57.228306	15.933448	24.198658	2.639589
15	3.34722	57.181995	15.963311	24.174787	2.679907
16	3.35754	56.864675	15.987840	24.482789	2.664696
17	3.36037	56.870486	15.986649	24.479027	2.663839
18	3.36105	56.856373	15.990360	24.481963	2.671305
19	3.36308	56.824400	15.971081	24.505141	2.699378
20	3.36522	56.752657	15.970096	24.579642	2.697605
21	3.36571	56.739047	15.970898	24.582098	2.707957
22	3.36831	56.655167	15.980215	24.660499	2.704119
23	3.36889	56.662587	15.978171	24.655222	2.704019
24	3.36911	56.655625	15.979906	24.659851	2.704618

App G.3.2

DECOMPOSITION OF VARIANCE

STEP	STAN ERR	PCDTSA	PCISCPI	D1	D2HAT
In CPI:					
1	1.72528	0.000465	99.999535	0.000000	0.000000
2	1.90410	0.096993	98.738895	0.731975	0.432137
3	1.95635	0.888692	93.913019	2.151275	3.047014
4	2.00562	4.214253	90.086738	2.055552	3.643457
5	2.03296	4.142442	88.684518	3.457787	3.715253
6	2.05080	4.164752	88.274031	3.400000	4.161216
7	2.09224	4.425536	85.896343	5.679891	3.998230
8	2.09652	4.709893	85.600154	5.661815	4.028139
9	2.10740	4.808421	84.917314	6.143332	4.130933
10	2.11444	5.296155	84.352936	6.122074	4.228834
11	2.11659	5.294857	84.182177	6.272075	4.250891
12	2.11956	5.304398	84.022302	6.284138	4.389162
13	2.12834	5.337512	83.510199	6.794443	4.357846
14	2.12974	5.428121	83.418947	6.792978	4.359954
15	2.13263	5.429741	83.280906	6.917094	4.372259
16	2.13432	5.543567	83.150381	6.909537	4.396515
17	2.13465	5.546977	83.124960	6.929492	4.398571
18	2.13539	5.548487	83.075556	6.944030	4.431927
19	2.13730	5.552662	82.969916	7.050971	4.426451
20	2.13770	5.576003	82.940427	7.057297	4.426273
21	2.13841	5.573461	82.909133	7.089646	4.427760
22	2.13881	5.600320	82.878415	7.087310	4.433955
23	2.13887	5.602329	82.874376	7.089375	4.433919
24	2.13907	5.602384	82.859674	7.096338	4.441603

App G.3.3

DECOMPOSITION OF VARIANCE

STEP	STAN ERR	PCDTSA	PCISCPI	D1	D2HAT
In D1:					
1	0.244452	2.186874	8.309107	89.504019	0.000000
2	0.300622	16.763888	9.781738	73.452864	0.001510
3	0.315370	18.513454	12.513017	68.701418	0.272111
4	0.340097	17.619276	13.451019	66.911667	2.018037
5	0.356549	16.183706	13.147180	68.225768	2.443346
6	0.359694	15.923811	13.331237	67.858035	2.886918
7	0.383119	14.045590	13.326498	70.013059	2.614853
8	0.389109	14.890880	13.493421	69.069379	2.546320
9	0.392251	14.889523	13.511086	69.087890	2.511501
10	0.398600	14.894977	13.311037	69.023400	2.770585
11	0.401071	14.775101	13.368488	69.076708	2.779703
12	0.402436	14.680394	13.285106	69.121399	2.913100
13	0.407780	14.298251	13.396127	69.455118	2.850504
14	0.408674	14.507564	13.428726	69.224780	2.838930
15	0.409811	14.443690	13.441080	69.292013	2.823217
16	0.411367	14.476413	13.394159	69.252541	2.876887
17	0.411665	14.467180	13.409065	69.248512	2.875243
18	0.412220	14.428320	13.374128	69.287554	2.909997
19	0.413420	14.346325	13.413727	69.344789	2.895159
20	0.413566	14.396824	13.414093	69.295969	2.893114
21	0.413953	14.370194	13.420029	69.321631	2.888147
22	0.414305	14.384879	13.410006	69.305191	2.899924
23	0.414329	14.384795	13.412943	69.302665	2.899597
24	0.414527	14.371165	13.402439	69.318245	2.908151

App G.3.4

DECOMPOSITION OF VARIANCE

STEP	STAN ERR	PCDTSA	PCISCPI	D1	D2HAT
In D2HAT:					
1	0.107145	2.123344	0.102420	0.724085	97.050151
2	0.162058	32.124014	1.959747	19.129004	46.787236
3	0.217670	20.852081	23.086890	29.531594	26.529436
4	0.236966	17.625592	30.494779	28.025004	23.854626
5	0.252323	19.903740	30.045545	28.841257	21.209458
6	0.253835	20.750848	29.767975	28.511348	20.969829
7	0.255986	20.755242	29.391896	28.038436	21.814425
8	0.259311	21.558504	29.030787	27.604091	21.806618
9	0.262279	21.430898	28.386927	28.793631	21.388544
10	0.263935	21.163210	28.768125	28.587988	21.480677
11	0.267025	21.350957	28.600564	28.944074	21.104404
12	0.267626	21.672862	28.502806	28.814529	21.009802
13	0.268084	21.647845	28.505207	28.716368	21.130580
14	0.268804	21.795880	28.452390	28.592656	21.159074
15	0.269514	21.773519	28.325958	28.843101	21.057422
16	0.269786	21.731029	28.383135	28.792264	21.093572
17	0.270511	21.737315	28.351370	28.898747	21.012568
18	0.270679	21.829182	28.319640	28.864065	20.987113
19	0.270767	21.819719	28.326374	28.845568	21.008339
20	0.270931	21.851905	28.313875	28.812860	21.021360
21	0.271100	21.848097	28.287858	28.868248	20.995798
22	0.271151	21.841056	28.296113	28.857437	21.005393
23	0.271323	21.835445	28.292468	28.885166	20.986921
24	0.271369	21.859876	28.283112	28.876661	20.980351

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